

The University of Chicago

A LABORATORY STUDY OF THE
RELATION OF SELECTED FACTORS
TO THE SPAN OF RECOGNITION
IN SILENT READING

A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE SOCIAL SCIENCES IN
CANDIDACY FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY

DEPARTMENT OF EDUCATION

1941

By

THEODORE LESTER HARRIS

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CHAPTER I

INTRODUCTION

The Purpose of the Study

The purpose of this study is to measure the span of recognition at various levels of school progress and to determine the relation of selected factors to it.

The Relation of the Span of Recognition to Reading Efficiency

The span of recognition is an important criterion of reading efficiency for it is indicative of the relative maturity of one's perceptual habits in the process of reading.¹ The beginning reader is characteristically inefficient in his reading habits in that he displays a narrow or immature average span of recognition. On the other hand, a broad, mature span of recognition should signify that the reader has mastered the purely recognition aspects of the reading process and is thus relatively free to deal with the interpretative aspects of the printed material. Such a reader grasps a large unit of the printed page at each fixation pause of the eyes. The possession of an effective reading habit in this sense, however, should denote not only superior command over the fundamental eye-movements involved, but also an accurate and intelligent reaction to the meaningful content of the material read, for usually good eye-movement habits are but the reflection of such a reaction. Mere possession of good eye-movement habits, on the other hand, without the ability to successfully derive meaning from the printed page violates the fundamental purpose of the process of reading. A broad span of recognition that is the result of accurate and thoughtful reaction to reading materials should thus be a basic objective of reading efficiency.

¹See G. T. Buswell, Fundamental Reading Habits: A Study of Their Development, p. 30. Supplementary Educational Monographs, No. 21. Chicago: Department of Education, University of Chicago, 1922.

The Status of Present Knowledge About the Span of Recognition

Specific information regarding the size of the average span of recognition at various grade levels and the nature of its development has been revealed by the study referred to in the preceding paragraph. Information regarding the influence of various factors upon the span of recognition, however, is very limited indeed, and is summarized in chapter ii. The present study was undertaken largely because of a well-recognized need for more accurate information concerning factors which may affect the size of the span of recognition when the latter is studied by means of the use of controlled techniques upon a sizeable group of subjects. To the knowledge of the writer, no study has been previously reported in which the span of recognition was thus intensively investigated in relation to many different factors.

The Need for Further Information About the Span of Recognition

The need for information regarding some of the factors which may influence the size of the span of recognition grows largely out of the necessity faced by educators for knowing more about how to produce a desired type of learning product. It is not enough to know that a large span of recognition is a desirable aspect of reading ability. It is also important to know how such an outcome may be brought about. In order that this goal may be achieved, factors which influence the development of a broad span of recognition must first be identified, while those factors of relatively little significance must likewise be recognized and relegated to their proper place in any program designed to foster the development of a mature span of recognition. One function of this study is therefore the identification of some of the factors which are significantly associated with the size of the span of recognition in order that appropriate steps may be taken in developing a broad span of recognition.

The Plan of the Study

The current study is devoted in the first place to a summary of the basic facts known about the span of recognition and those factors which have been studied in conjunction with it. This information is given in chapter ii, which concludes with a

statement of the types of factors included in the present investigation. More specific details regarding the organization and administration of the study follow in chapter iii.

Chapters iv, v, and vi deal with the results of the investigation. Chapter iv contains an analysis of the basic data secured regarding the span of recognition and a comparison of the growth trends found for the span of recognition with those secured by Buswell in an earlier study.¹ Correlation coefficients for each of the factors included in the present study are given in chapter v, together with a discussion of the relative significance of each factor. Chapter vi deals with the interpretative aspects of the study. In this chapter are included (1) a critical examination of the distribution and group trends of the data, (2) case studies of good and poor readers, and (3) a discussion of the relation of the current study to the general field of visual perception. The final chapter briefly summarizes the conclusions of the study and suggests implications of the study both for training in the development of a broad span of recognition and for further research relating to the span of recognition.

¹Ibid., pp. 11-36.

CHAPTER II

BASIC ASPECTS OF THE SPAN OF RECOGNITION

The purpose of this chapter is to review the major facts known about the span of recognition and to discuss the types of factors selected for this study. The first part of the chapter is devoted to differentiating between the terms "span of recognition" and "span of perception," to surveying the development of the span of recognition from the first grade through the college freshman level, and to stating briefly the present knowledge of factors that have been studied in relation to the span of recognition. The discussion then turns to the kinds of factors with which the present investigation is concerned.

The Span of Recognition Versus the Span of Perception

Definition of the span of recognition.--The basic factor considered in the current study has been defined by Buswell for the normal reading situation as the "amount of print which can be recognized in a single pause or fixation of the eyes."¹ It is important to note that this use of the term has been applied consistently by experimenters at the University of Chicago and by others to a span which is determined by the fixation pauses of the eyes in continuous reading.

The span of perception.--The span of perception, on the other hand, has a specific meaning in psychological usage that differentiates it from the span of recognition. The span of perception is defined by Tinker as "the number of items that can be recognized or named from a single visual impression whose duration is shorter than the reaction time of the eye."² In another

¹G. T. Buswell, How Adults Read, p. 54. Supplementary Educational Monographs, No. 45. Chicago: Department of Education, University of Chicago, 1937.

²M. A. Tinker, "How Formulae Are Read," American Journal of Psychology, XL (July, 1928), 476.

connection, Tinker¹ indicates that he uses the terms "span of perception" and "span of apprehension" interchangeably. It will be noted that a definition such as the one cited for the span of perception implies that this type of measure of span in reading be derived by the short-exposure technique of the tachistoscope. Otherwise, it would be difficult to guarantee that the eye made one and only one fixation for a given exposed stimulus. One investigator, indeed, has used an exposure as long as three seconds to secure what he termed the "reading span" of his subjects,² but his procedure and terminology have not been widely followed. Clearly an exposure of three seconds would allow time for several fixations of the eyes.

These and other differences in the measurement of a span for reading of print are widely reflected in the literature of the psychology of reading, causing one writer, Vernon, to remark after a survey of this subject: "The use of these various terms, perceptual span, reading span, span of attention (which seems to correspond to the perceptual span), range of visual apprehension, makes it difficult to be certain just what these workers have studied."³ Tinker's definition and use of the term "span of perception," however, have become well recognized in recent years and are adhered to in this study.

Differences between the span of recognition and the span of perception.--There are both qualitative and quantitative differences between the span of perception and the span of recognition. Qualitative differences relate to differences in set between these two measures, to differences in the utilization of the total perceptual field in a given span, and to differences in the relationship of successive spans.

In the first place, Hamilton⁴ has made a thorough analysis of the differences in set between the tachistoscopic span and the

¹Idem, "Visual Apprehension and Perception in Reading," Psychological Bulletin, XXVI (April, 1929), 224.

²W. H. Pyle, "The Reading Span," Elementary School Journal, XXIX (April, 1929), 597-602.

³M. D. Vernon, The Experimental Study of Reading, p. 128. Cambridge, England: Cambridge University Press, 1931.

⁴Francis M. Hamilton, The Perceptual Factors in Reading. Columbia University Contributions to Philosophy, Psychology, and Education, Vol. XVII, No. 1. New York: Science Press, 1907.

span in normal reading. The tachistoscopic set is much more intense, it was found, and results in more rapid perception than the set characteristic of the normal reading situation. Aveling,¹ furthermore, has shown that the amount of conation involved in the two cases is different, normal perception apparently containing an optimum amount of conation, while straining to perceive a stimulus in tachistoscopic perception tends to divert energy away from the act of perception itself. In the second place, the tachistoscopic span is an absolute measure of span, as Brooks² has indicated, and is, as is suggested by the definition, essentially a static measure of perceptual ability. The same writer has, in the third place, pointed out that by comparison, the span of recognition is a relative measure of span.³ For example, in the normal reading situation there is much overlapping of successive acts of fixation, due to the continuous associative processes which are characteristically put into motion in normal reading.⁴ This overlapping means that while the reader may be using his full span of perception in normal reading, nevertheless the successive fixation points are so close together as to produce on the average a narrow span of recognition, such that the latter is typically smaller than the span of perception.

Many investigators have confirmed this quantitative relationship. A recent investigator, Robinson,⁵ found that for a group of fifty-one unselected college students, the average span of recognition was 1.64 words while the average span of perception

¹F. Aveling, "The Perception of Tachistoscopically Exposed Symbols," British Journal of Psychology, XXII (January, 1932), 193-99.

²F. D. Brooks, The Applied Psychology of Reading, p. 32. New York: D. Appleton and Co., 1926.

³Ibid.

⁴See Floyd C. Dockeray, "The Span of Vision in Reading and the Legibility of Letters," Journal of Educational Psychology, I (March, 1910), 123. C. T. Gray, Types of Reading Ability as Exhibited through Tests and Laboratory Experiments, p. 127. Supplementary Educational Monographs, Vol. I, No. 5. Chicago: Department of Education, University of Chicago, 1917.

⁵F. P. Robinson, "The Tachistoscope as a Measure of Reading Perception," American Journal of Psychology. XLVI (January, 1934), 133.

was 3.39 words. Walker,¹ working with a group of superior readers at the college level, obtained results approximating those of Robinson and concluded that the average span of perception was approximately two times the average span of recognition for his group. The results cited apply in both cases to meaningful materials. Tinker has pointed out that in the measurement of the span of perception there is a "tendency to combine the different elements of a visual impression into higher perceptual units whenever grouping is possible."² The culmination of this tendency is to be found in the grouping of words into the "higher perceptual units" of phrases and sentences for which, as would be expected, larger spans of perception were obtained than for objects, numbers, and letters even when these were grouped in various ways, as the same writer has shown.³

If these definitive facts concerning the quantitative differences between the span of recognition and the span of perception are kept in mind, there should be little or no confusion or misunderstanding concerning the relative size of these measures of span. To quote Buswell's admonition in this respect:

The reader should not confuse this measure [the recognition unit obtained in a tachistoscope] with that secured by finding the average number of fixations per line. The former shows the limits of the recognition unit; the latter shows the normal recognition-span used in reading.⁴

Furthermore, it should be kept in mind that as Dodge⁵ early pointed out, perception during tachistoscopic exposure is quite different from perception during the fixational pauses of normal reading, the former tending to give an exaggerated picture of apprehension during normal continuous reading.

¹Robert Y. Walker, "The Eye-Movements of Good Readers," University of Iowa Studies in Psychology, No. 17, pp. 95-117. Edited by Christian A. Ruckmick. Psychological Monographs, Vol. XLIV, No. 3. Princeton, New Jersey: Psychological Review Co., 1932.

²Tinker. "Visual Apprehension and Perception in Reading," op. cit., p. 227.

³Ibid.

⁴Buswell, Fundamental Reading Habits, p. 30.

⁵Raymond Dodge, "Experimental Study of Visual Fixation," pp. 55-56. Psychological Review Monograph Supplement, No. 35 (Vol. VIII, No. 4). Princeton, New Jersey: Psychological Review Corp., 1907.

The Development of the Span
of Recognition

Since the span of recognition is an inverse function of the number of fixations, those studies which relate to eye-movement fixations likewise relate to the span of recognition. Of especial importance for the present study are experimental data which throw light upon fundamental aspects in the development of the span of recognition.

The most thorough study of the growth of eye-movement habits has been made by Buswell.¹ His study is confined largely to basic aspects of the reading process, namely, fixation frequency, duration of fixations, and regression frequency, and was made with subjects who were selected on the basis of their reading ability and considered typical of the various grade levels involved. Buswell found definite growth trends in the average number of fixations made at various grade levels from the first grade through the college freshman year. For example, the average fixation frequency decreased very rapidly in Grades I through IV, became more stable for Grades V through VIII inclusive, and decreased significantly again in Grades IX and X. Buswell's data also showed that some readers had fairly mature recognition habits as early as the fourth grade; that is, there were few fixations per line and the eye progressed across the page regularly with a minimum of regressive movements. Average regression frequency likewise decreased rapidly in the first four grades, with a subsequent decrease in the eighth grade, after which there was little significant change. Data reported by Davidson² indicate, in fact, that in some superior children good eye-movement habits may be established as early as three and one-half years. On the other hand, children who fail to develop mature habits in the mechanics of reading frequently become remedial cases with eye movements characteristic of the immature

¹Buswell, Fundamental Reading Habits. Detailed comparison of the results of the present study with that of Buswell is made in chapter iv.

²H. P. Davidson, "An Experimental Study of Bright, Average, and Dull Children at the Four-Year Mental Level," Genetic Psychology Monographs, IX (March-April, 1931), 214-18.

or beginning reader, as William S. Gray¹ has shown.

The concept of maturity of the reading habit as advanced by Buswell appears to be of definite value in that it identifies those readers who are efficient in their fundamental reading habits. As was pointed out in chapter 1, the person who uses a wide span of recognition has adjusted his perceptual processes to deal with larger thought units which in turn make the latter processes more efficient.² On the other hand, Vernon³ found that in readers whom she considered mature there was evidence of two rather distinct general types of reading habits: (1) a habit which involves few fixations of long duration, and (2) a habit which involves many fixations of short duration. C. T. Gray⁴ secured evidence of a similar nature. The maturity of the latter type of eye-movement habit is open to question, of course, depending upon one's definition of mature reading ability. However, since Buswell used material of second-grade difficulty for testing subjects at all levels, it seems reasonable to assume that the more mature readers would be characterized by significantly different and more efficient reading habits than those of lesser reading ability. A most significant difference, it appears to the writer, is the possession of a broader span of recognition on the part of the more expert readers.

The span of recognition in reading, therefore, shows definite growth from the stage of beginning reading, which is characterized by a narrow span of recognition, many regressions, and resultant irregular progress across the line of print, to that of the mature reader who has a wide span of recognition with regular and accurate eye movements. Perhaps further valuable light could be thrown upon the development of the basic eye-

¹William S. Gray (with the co-operation of Delia Kibbe, Laura Lucas, and Lawrence W. Miller), Remedial Cases in Reading: Their Diagnosis and Treatment, pp. 91-129. Supplementary Educational Monographs, No. 22. Chicago: Department of Education, University of Chicago, 1922.

²Buswell, Fundamental Reading Habits, p. 30. G. T. Buswell, Remedial Reading at the College and Adult Level: An Experimental Study, pp. 11, 62. Supplementary Educational Monographs, No. 50. Chicago: Department of Education, University of Chicago, 1939.

³Op. cit., p. 93.

⁴Op. cit., pp. 93-94.

movement habits were a longitudinal study to be made, as Tinker¹ has suggested. It seems evident, however, that the essential nature of the development of the mature span of recognition has been disclosed by Buswell's investigation.

Evidence of the Relationship of Various Factors
to the Span of Recognition

The relationship of various factors to the span of recognition may be sought by the precise quantitative method of correlation, by less precise but informative methods of comparison such as that of comparing the characteristics of superior with inferior readers with respect to the factors studied, or by inference. The discussion of evidence in this section will be limited largely to that which has been revealed by the first-mentioned method. Pertinent information derived by other methods will be introduced when feasible in the discussion of the results of the study. It might be pointed out, however, that the selection of factors to be studied has been influenced to some extent by the third method mentioned above. For example, inference guided the inclusion of two speed of association tests for experimental purposes, largely as a result of a study by Traxler² who found a positive correlation between speed of association and speed of reading on certain tests.

Evidence of the relationship of various factors to the span of recognition by means of correlation techniques is meager. Robinson³ found a correlation of $.52 \pm .07$ between the span of recognition and the span of perception in his study of fifty-one college students. This is a considerably higher correlation than that found by Litterer,⁴ who correlated span of perception with fixation frequency and secured raw coefficients between these two factors of $-.437$ for the reading of easy prose and $-.383$ for

¹M. A. Tinker, "Eye Movements in Reading," Journal of Educational Research, XXX (December, 1936), 251.

²Arthur E. Traxler, "The Relation between Rate of Reading and Speed of Association," Journal of Educational Psychology, XXV (May, 1934), 357-65.

³Op. cit.

⁴O. F. Litterer, "An Experimental Analysis of Reading Performance," Journal of Experimental Education, I (September, 1932), 31.

scientific prose for seventy-odd psychology students at the college sophomore level. When corrected for attenuation, the coefficients read $-.463$ and $-.442$ respectively. The negative correlation signifies that to a certain extent at least, increase in the span of perception was accompanied by a decrease in the number of fixations. Both of these studies show a significant relationship between the factors studied, although it is not one high enough to use for diagnostic purposes in individual cases.

In the same study, Litterer correlated fixation frequency with paragraph comprehension on the Iowa Silent Reading Test (unrevised) and with two measures of reading speed, the Minnesota Speed of Reading Test and the Chapman Speed of Reading Test. Raw correlation coefficients (with coefficients corrected for attenuation shown in parentheses) were as follows for easy prose: Iowa paragraph comprehension, $-.476$ ($-.531$); Minnesota Speed of Reading, $-.327$ ($-.381$); and Chapman Speed of Reading, $-.433$ ($-.519$). For scientific prose the correlations were: Iowa paragraph comprehension, $-.450$ ($-.548$); Minnesota Speed of Reading, $-.326$ ($-.414$); and Chapman Speed of Reading, $-.513$ ($-.671$). The correlation coefficients in each case are significant.

A low but significant correlation has been reported by Leavell and Sterling¹ for the span of recognition and intelligence. Working with 191 sixth-grade pupils, these investigators secured a correlation coefficient between the latter factors of $.36 \pm .04$. The measure of intelligence used in this case was the Kuhlman-Anderson group intelligence test.

The relationship of two other elements which figure prominently in the reading process will be mentioned briefly because of their significance in connection with the span of recognition. Judd and Buswell² reported that a generally smaller span of recognition, accompanied by increased duration of fixations, resulted from increase in the difficulty of materials. The sub-

¹U. W. Leavell and H. Sterling, "A Comparison of Basic Factors in Reading Patterns with Intelligence," Peabody Journal of Education, XVI (November, 1938), 149-55.

²C. H. Judd and G. T. Buswell, Silent Reading: A Study of the Various Types, pp. 7-26. Supplementary Educational Monographs, No. 23. Chicago: Department of Education, University of Chicago, 1922.

jects of their study were taken from the fifth grade. Anderson,¹ and Walker² in a study of good readers, reported similar results at the college level, although Walker found that his group showed comparatively little difference in the extent of their forward eye movements during the reading of more difficult materials.

There is likewise considerable evidence that eye-movement habits vary with the attitude or purpose of the reader, as Judd and Buswell,³ Anderson,⁴ and others have demonstrated. The former writers showed that instructions to re-read materials for questioning produced a significant tendency to increase the number and to decrease the duration of fixations, which resulted in a narrower span of recognition. Regressions likewise tended to increase. These writers found, furthermore, that instructions to paraphrase resulted in eye movements that showed periods of great confusion much like those of beginning reading, which were probably due to unfavorable emotional reactions and to lack of practice in such activity. Anderson,⁵ in fact, considered that purpose or attitude was of more importance in determining eye-movement regularity than was the difficulty of the materials which he used. Thus, for example, reading for the general idea, reading for detail, and reading at one's normal rate would produce considerably different eye-movement patterns.

Types of Factors Selected for the Present Study

The evidence cited in the preceding section was limited, it will be noted, to factors of a psychological nature that have been studied in connection with the span of recognition. Thus intelligence, different measures of reading ability, the span of perception, and to a less precise extent, the effect of attitude and difficulty of materials, have been studied and appear to have a definite influence upon it. Accordingly, some factors from this group were selected for inclusion in the current study in

¹Irving H. Anderson, "Studies in the Eye-Movements of Good and Poor Readers," Studies in the Psychology of Reading, I, 1-35. Edited by Joseph Tiffin. University of Iowa Studies in Psychology, No. 21. Psychological Monographs, Vol. XLVIII, No. 3. Princeton, New Jersey: Psychological Review Co., 1937.

²Op. cit.

³Op. cit., pp. 27-46.

⁴Op. cit.

⁵Ibid.

order to verify or modify the degree of relationship already observed. However, since this study, as was pointed out in chapter 1, has as one of its chief functions the identification of several different factors which may be significantly associated with the span of recognition, the problem of the effect of different attitudes and of different degrees of difficulty of materials was not entered upon. The reason for this was that the complexity of the latter factors is so great as to warrant that each be made the subject of a separate investigation.

A second type of factor other than psychological, but which has received increasing attention in connection with the reading process in recent years, relates to visual abilities. Since the clearness and the comfort with which one sees is obviously conditioned by the efficiency of the visual apparatus, it is but natural that vision should receive considerable emphasis in an activity which has to do with the interpretation of visual symbols. Current interest in the relation of vision to the problem of reading is evidenced by the existence of visual tests such as the Telebinocular tests which are advocated for use in connection with the diagnosis and the prevention of reading difficulties, by the appearance in the last decade of over a score of reports and summaries of research dealing with the relation of various aspects of reading to vision, and by the inclusion of sections devoted to this same topic in more recent texts on reading.¹ Still another kind of evidence which demonstrates the increase of interest in this subject is the appearance since 1929 of articles describing the role of vision in reading by eye specialists. Previous to this time the investigation and discussion of vision in relation to reading was confined almost exclusively to psychologists and educators who were interested in the problem.

Typically, the procedure in studies of the relation of vision to reading has been to compare the frequency and degree of visual defects in selected good and poor readers, or to compare the latter group with an unselected school population. The measures of reading ability used in these studies, however, are ordinarily those of general reading ability, and not a laboratory

¹See, for example, Emmett A. Betts, The Prevention and Correction of Reading Difficulties. Evanston, Illinois: Row, Peterson and Co., 1936. Paul A. Witty and David Kopel, Reading and the Educative Process, pp. 210-13. Boston: Ginn and Co., 1939.

criterion such as the span of recognition. It should be pointed out, too, that there are many disparities in the results of already published studies, as an analysis by Betts¹ makes clear. Betts notes at least four reasons for such disparities: (1) differences in the amount of reading disability involved, (2) unevenness in the quality of the instruction, (3) variations in the kind of visual examination given, and (4) discrepancies in the skill with which the visual examination is administered. All of these reasons contribute to the inconclusiveness of the results of such studies in so far as the relation of vision to reading ability is concerned. A study which provides an excellent illustration of the effect which the amount of reading disability, for example, may have upon the degree of relationship between vision and reading is that of Edna A. Harris.² She found that while there was a positive relationship between visual defects and reading ability in the extremes of a group of 758 children, there was a lack of significant relationship when the pupils of the tenth above and below the grade norm were compared. The bulk of the evidence tends to indicate, however, that for those factors ordinarily included in a visual examination, visual defects occur in about equal frequency in both good and poor readers.³

The fact that visual abilities have been widely studied in relation to reading with but indirect implications as far as their precise significance to variations in the span of recognition is concerned, has led to the inclusion in this study of

¹Emmett A. Betts, "Visual Aids in Remedial Reading," Educational Screen, XV (April, 1936), 108-10.

²Edna A. Harris, "The Relationship between Defective Vision and Achievement in Reading." Unpublished Master's Thesis, Department of Education, University of Chicago, 1937.

³See representative studies such as: L. P. Farris, "Visual Defects as Factors Influencing Achievement in Reading," California Journal of Secondary Education, X (October, 1934), 50-51. Paul Fendrick, Visual Characteristics of Poor Readers. Teachers College Contributions to Education, No. 656. New York: Columbia University, 1935. Henry A. Imus, J. W. M. Rothney, and R. M. Bear, An Evaluation of Visual Factors in Reading. Hanover, New Hampshire: Dartmouth College Publications, 1938. Donald E. Swanson and Joseph Tiffin, "Betts' Physiological Approach to the Analysis of Reading Disabilities as Applied to the College Level," Journal of Educational Research, XXIX (February, 1936), 433-48. Paul A. Witty and David Kopel, "Factors Associated with the Etiology of Reading Disability," ibid., pp. 449-59.

selected visual factors for investigation. It is hoped, as a result, that a more accurate understanding of their role with respect to the span of recognition may be acquired. The inclusion of factors of this nature, furthermore, gives an opportunity for the comparison of the significance of visual and psychological factors in differentiating readers with narrow and broad spans of recognition. The selection of specific factors is discussed in detail in chapter iii.

The study as a whole thus focuses attention upon one significant phase of the reading process and studies the relationship of both psychological and visual factors to it. No attempt has been made to isolate only those factors which determine the span of recognition, but rather to select those which could most advantageously and justifiably be brought within the scope of the laboratory. This step was necessitated by the fact that the span of recognition is the complex product of many factors, such as native ability, training, the type of material read, the purpose for which material is read, and the conditions under which it is read. Many of the conditioning factors could not be studied at this time due to limitations of time and space.

CHAPTER III

THE ORGANIZATION AND ADMINISTRATION OF THE STUDY

The present chapter is largely concerned with (1) the kinds of subjects chosen for the study and the grade levels which they represent, (2) the organization and the procedure of the study, (3) the specific materials, instrumentation, and techniques used, and (4) the conditions which obtained for the study as a whole. This discussion is preceded by a brief consideration of the requirements of a scientific study and a statement of two major assumptions upon which this investigation rests.

The Requirements of a Scientific Study

The analysis of the organization and administration of the current study may well be prefaced by consideration of the broader question, "What are the requirements of a scientific study?"

It appears to the writer that a scientific study should, in the first place, set forth the primary assumptions upon which the study rests, for in this way the theoretical foundation of the study is established. In the second place, data for a scientific study should be objective. Such data should likewise be valid; that is, appropriate to and representative of the factor or factors being studied. The data should also be reliable, so that it may be verified by other investigators working under the same conditions. In order to secure objective data that meet these requirements, it is necessary, in the third place, to use controlled techniques and accurate instruments, and to practice precision in the observation and recording of data so that the method is not haphazard, but systematic. By following such a method in the observation of an adequate sample of material, data that are reliable may be secured. Once reliable data are gathered, finally, valid methods of interpretation should be followed in order that the data will not be falsified.

This study attempts to meet these requirements.

Assumptions Underlying the Study

A major assumption of the study is that the psychological factors used in this investigation are for the most part significantly associated with the span of recognition. The same assumption, however, cannot be made for the visual factors inasmuch as the evidence of their relationship to the span of recognition is indirect and inconclusive.

A further assumption of the study is that the materials and procedures used yield valid evidence of the degrees of relationship between the factors studied and the span of recognition. Examination is next made of some of the factual bases upon which this assumption rests.

The Subjects of the Study

Source of subjects.--Subjects at the university level were chosen from the freshman class of the University of Chicago. The co-operation of this group was entirely voluntary and by appointment.

Subjects at all other grade levels were obtained through the co-operation of the elementary and high schools of Mooseheart, Illinois, and through the co-operation of the Mooseheart Laboratory for Child Research. Since the Mooseheart schools are of a unique character and are private, not public institutions, the community and schools of Mooseheart will be discussed briefly.

Mooseheart is a city which at the same time is both a home and a school for dependent children of deceased members of the Loyal Order of Moose. The student residents of Mooseheart live in a series of homes, each of which has at least one house-mother and one cook to care for a family of foster boys or girls, which average about fifteen children to a home. In the homes of junior and senior high-school boys, it is the practice to employ a married couple as well as a cook.

All students at Mooseheart are given a high-school academic training in addition to specific vocational training. The high school has been a member in good standing of the North Central Association of Colleges and Secondary Schools since 1921, while all divisions of the schools are accredited by the State Department of Public Instruction. A recent publication¹ indicates

¹W. J. Leinweber, Mooseheart and Its Special Youth Building Program, p. 3. Mooseheart Monograph No. 1. Printed by Student Printers at Mooseheart, Illinois, 1938.

that only normal children are admitted to Mooseheart and that any very young children suspected of being feeble-minded are admitted on probation pending the results of further testing. It should be emphasized, therefore, that the subjects used in this study which were derived from Mooseheart are normal children who come from accredited schools. Any shortcomings which this group might suffer when compared to a normal public-school group would probably be primarily attributable to broader experiential factors and to the influence of the home, both of which favor the public-school population.

Grade levels from which subjects were drawn.--The earlier investigation of Buswell¹ showed the nature of the development of the span of recognition from the first grade through the college level. It was therefore not thought necessary in this study to duplicate the same type of grade-by-grade analysis at each of these levels. However, Buswell's study showed that the period of most rapid progress in the development of the span of recognition was during the early grades of the elementary school, while a plateau extended through the middle-grade period. Accordingly, Grades II through VI were selected for the current study in the hope that these grades would reveal a similar type of growth of the span of recognition. The first grade was omitted because of the difficulty of preparing materials which were at the same time suitable for both that grade and also the other grade levels involved.

Significant increase in the average size of the span of recognition over that at the sixth-grade level was likewise found by Buswell at the ninth grade. Since this grade level marks the initial period of a four-year high school, or the final year of a typical junior high school type of organization, it was also included in the present study. The freshman year of college or university was likewise selected in order to secure data comparable with that of the highest level included in Buswell's study and to provide a measure of reading ability at the beginning of the period of higher education. Thus the early and middle periods of the elementary school are well represented, with additional grades selected to represent the beginning periods of secondary and higher education.

¹Buswell, Fundamental Reading Habits.

Number, age, and sex differences.--Table 1 shows the number of subjects involved in the study at each grade level, the total number for all grade levels being 200. With a few exceptions, complete data on all factors investigated are available.

TABLE 1
NUMBER OF SUBJECTS PER GRADE LEVEL

Grade Level	Number of Subjects
II	19
III	22
IV	24
V	35
VI	30
IX	35
XIII	35
Total	200

Table 2 shows the distribution of ages at each grade level and gives the median age in each case. The restricted age range of the ninth grade is due to the way in which subjects for that grade were selected, as will be shown more fully in the following section.

Table 3 gives the sex differences of the subjects in each grade.

Bases of selection.--All pupils in Grades II to VI of the co-operating schools were included, with the exception of a group of eleven much-retarded pupils enrolled in a special-help section. At the ninth-grade level, selection upon an age-grade basis was not entirely feasible, and was therefore limited to the superior of the two groups of students available, plus four students from the second group who most closely approximated the age-level of the superior group. Such selection had a definite effect upon certain aspects of the study, as will be shown later.

The thirty-five students selected at the college level were chosen from a group of over seven hundred students on the basis of a representative sampling of speed of reading ability as evidenced by the scores made on freshman entrance tests in reading. This was done in order to insure a broader sampling of speed

TABLE 2
DISTRIBUTION OF AGES PER GRADE LEVEL

Year and Month	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
7-1 to 7- 6...	4	....	....	....	....	....	....	4
7-7 to 7-12...	5	2	....	....	....	....	....	7
8-1 to 8- 6...	4	3	....	....	....	....	....	7
8-7 to 8-12...	5	6	....	....	....	....	....	11
9-1 to 9- 6...	1	7	9	....	....	....	....	17
9-7 to 9-12...	....	2	5	1	....	....	....	8
10-1 to 10- 6...	....	2	5	5	....	....	....	12
10-7 to 10-12...	....	....	2	10	....	....	....	12
11-1 to 11- 6...	....	....	2	13	5	....	....	20
11-7 to 11-12...	....	....	1	4	6	....	....	11
12-1 to 12- 6...	....	....	....	2	8	....	....	10
12-7 to 12-12...	....	....	....	....	6	....	....	6
13-1 to 13- 6...	....	....	....	....	4	2	....	6
13-7 to 13-12...	....	....	....	....	1	....	....	1
14-1 to 14- 6...	....	....	....	....	....	10	....	10
14-7 to 14-12...	....	....	....	....	....	10	....	10
15-1 to 15- 6...	....	....	....	....	....	11	....	11
15-7 to 15-12...	....	....	....	....	....	2	....	2
16-1 to 16- 6...	....	....	....	....	....	....	1	1
16-7 to 16-12...	....	....	....	....	....	....	....	0
17-1 to 17- 6...	....	....	....	....	....	....	4	4
17-7 to 17-12...	....	....	....	....	....	....	3	3
18-1 to 18- 6...	....	....	....	....	....	....	13	13
18-7 to 18-12...	....	....	....	....	....	....	4	4
19-1 to 19- 6...	....	....	....	....	....	....	5	5
19-7 to 19-12...	....	....	....	....	....	....	3	3
20-1 to 20- 6...	....	....	....	....	....	....	1	1
20-7 to 20-12...	....	....	....	....	....	....	....	0
21-1 to 21- 6...	....	....	....	....	....	....	....	0
21-7 to 21-12...	....	....	....	....	....	....	....	0
22-1 to 22- 6...	....	....	....	....	....	....	....	0
22-7 to 22-12...	....	....	....	....	....	....	1	1
Total.....	19	22	24	35	30	35	35	200
Median.....	8-2	9-0	9-9	11-2	12-4	14-10	18-5	....

of reading ability than would probably have resulted from sampling conducted on other bases. That this method of sampling likewise resulted in a broad distribution according to size of the span of recognition is clear from data presented in chapter iv.

TABLE 3
SEX DIFFERENCES OF SUBJECTS PER GRADE LEVEL

Grade Level	Male	Female	Total
II	9	10	19
III	15	7	22
IV	14	10	24
V	22	13	35
VI	13	17	30
IX	16	19	35
XIII	19	16	35
Total.....	108	92	200

The Scope and Procedure of the Study

The discussion of the study will at this point be facilitated if an outline of the specific factors involved and a description of the general procedure of administering the study are given before each of these aspects of the study is discussed in detail.

Outline of factors investigated.--The ten psychological and nine visual factors chosen for study in relation to the span of recognition are as follows:

I. Psychological factors.

A. Data derived from the eye-movement record.

1. Average number of regressions.
2. Length of the eye-movement record, a measure of comparative speed of reading.

B. Data derived from standardized tests.

1. Intelligence.
2. Four measures of reading ability.
 - a. Reading rate in words per minute.
 - b. Comprehension of rate selection.
 - c. Word meaning or vocabulary.
 - d. Paragraph comprehension.

C. Data derived by means of special instrumentation.

1. Span of perception.
2. Speed of verbal association.
3. Speed of non-verbal association.

II. Physiological (visual) factors.

A. Data derived from Telebinocular tests.

1. Binocular acuity.
2. Fusion at the near point.
3. Vertical imbalance.
4. Lateral imbalance.
5. Sharpness of image at the near point.
6. Sharpness of image at the far point.
7. Stereopsis.

B. Data derived by means of special instrumentation.

1. Visual form span.
2. Blind spot.

Procedure in gathering the data.--As will be noted from the preceding outline of factors, the instrumentation employed in gathering data was of two general types: (1) standardized paper and pencil tests, in the case of measures of intelligence and general reading ability, and (2) laboratory instrumentation used for determining all other factors studied. The latter type of instrumentation included the Ophthalmograph, for securing the eye-movement record; a tachistoscope, for measuring the span of perception; a speed of verbal response mechanism, for measuring speed of association of ideas; a Telebinocular, for securing data on visual abilities; a perimeter, for measuring visual form span; and a campimeter, for plotting the extent of the blind spot. Each of these instruments is described more fully in the next section.

The routine of the examination procedure was the same for all subjects, according to the following outline:

1. Measurement of span of perception.
2. Telebinocular examination.
3. Measurement of speed of association.
4. Measurement of visual form span.
5. Photography of eye movements.
6. Measurement of blind spot.

The complete examination was administered individually to the university students during a single testing period. All other

students, however, took the examination in two sections, usually on successive days. This was done in order to avoid fatigue. The examination required from forty-five to sixty minutes for college students, while two one-half hour periods were used in the examination of other subjects.

The Laboratory Phase of the Study

The discussion of the laboratory procedures follows the routine order of the examination just outlined, with the exception that the photography of eye movements is considered first. In each case, the examination will be discussed with respect first to the materials used, second, to the instrumentation involved, and third, to the techniques of testing and recording the data.

1. Photography of Eye Movements

Materials.--The selection of materials was governed by the same considerations faced by Buswell in his earlier study, namely, to choose a selection of a very low level of difficulty yet with content of sufficient interest to engage the attention of readers of varying maturity. The assumption underlying the use of a single easy selection to be read at each of the grade levels is that in this way the degree of maturity of a specific habit such as the span of recognition is displayed while at the same time the factor of meaningfulness of the material is held practically constant. Photography of the eye movements of a subject while reading the selection gives the number of fixations per line, the average of which may then be converted into the average span of recognition.

The materials selected for the eye-movement photography constituted the first two paragraphs of the selection originally used and reproduced by Buswell in his Fundamental Reading Habits.¹

¹P. 23. The content of the first two paragraphs is as follows:

One night Peter went to bed early. It was not dark. The bright moon shone in at the window. Peter could see everything in the room. All at once he heard a noise. Peter opened his eyes. He saw that the room had grown dark. Something was outside the window.

Tap, tap, came a noise at the window. "What is it?" called Peter. "It is I, Peter. Come to the window." Peter climbed out of bed and went to the window. There he saw a bird. This bird was so large that his eyes were as big as saucers.

Since the original selection was available for use in the present study through the courtesy of Professor Buswell, the materials are strictly comparable with those used by Buswell except with regard to the length of the selection, that used in the earlier study being approximately one-third longer than in the present study. The selection was set solid in 12-point Century Expanded type with a uniform line length of 8.9 cm. The content of the material is of second-grade level in difficulty, so chosen in order to show the development of the span of recognition from that grade on.

Instrumentation.--An Ophthalmograph, a portable binocular eye-movement camera, was used to secure eye-movement records. The only modification of the instrument as manufactured by the American Optical Company was to insert blue-tinted glass over the sources of light reflected directly upon the cornea of the subject's eyes. The elimination of glare thus achieved was reported by subjects to give materially increased comfort in reading.

This instrument differed chiefly from that used by Buswell in that Buswell's instrument provided more rigid control of the head movements of a subject because it is a large stationary instrument with many refinements for laboratory experimentation. It should be noted, too, that the records secured by Buswell were monocular and not binocular ones. Other than these slight differences, however, the records may be considered comparable and entirely adequate for the kind of comparisons made in this study.

Techniques.--Standard techniques indicated in the manual accompanying the Ophthalmograph were followed. Each subject was asked to read the instruction card furnished with the Ophthalmograph. These instructions were then summarized orally by the operator before the card containing the selection to be read was exposed. All light except that from the Ophthalmograph was shut off during the adjustment to and the operation of the instrument. It was felt that sufficient time was given for accommodation of the eyes to this single light source during the adjustment of the instrument to each subject.

Immediately upon the completion of the eye-movement photography, the subjects were asked to answer "Yes" or "No" to the following statements which were read orally to them by the operator:

Peter went to bed early.

The bright moon shone when Peter went to bed.

The room was light when Peter opened his eyes.

The noise of a tap came at the window.

The rabbit called Peter to the window.

This procedure was adopted merely as a rough check upon the subjects' comprehension of the selection read and was obtained for all but the first ten of the (university) subjects of the study.

The eye-movement records of the subjects were analyzed for ten complete lines, the first and last lines of the selection being omitted. In the case of the incomplete line "window." occurring in the middle of the selection, fixations which obviously were made upon that word were not counted as a part of the following line nor as a part of the selection as a whole. Typically, a regression to the beginning of the next line followed fixation upon the word "window."

Six types of information were derived from the eye-movement records for the purpose of this study. First, the average number of fixations for the ten lines were calculated. Second, the average number of regressions were counted. Third, the average span of recognition was computed in centimeters by dividing the length of line by the average number of fixations per line. Fourth, the extent of the largest forward span between fixations that were not immediately preceded or followed by regressions was measured in millimeters by means of calipers. Fifth, the length of the entire eye-movement record for ten lines was measured in centimeters, excluding the fixation time noted previously which was devoted to the single-word line, "window." Where it was difficult to determine the duration of the fixation time for this word, due to lack of regression to the initial word of the following sentence, one-half of the fixation time of the initial fixation was assumed to have been devoted to the word "window." The sixth kind of information secured was a record of the apparent binocular co-ordination of the eyes in reading, as revealed by the degree to which the eyes tracked in parallel fixations upon the material read.

2. The Span of Perception

Materials.---In order to secure a measure of the span of perception that would be somewhat comparable to that derived for the span of recognition, it was thought necessary first of all to use materials of a similar low level of difficulty; second, to use

meaningful materials as in a normal reading situation; and third, to have the materials set up in the same type. Since standardized materials were not available, the writer was faced with the problem of preparing such materials.

The vocabulary used in the materials which were developed was taken from Stone's list of the 150 most important words for beginning reading,¹ so as to provide a basically easy body of content. The eighty-one words selected for presentation in a tachistoscope are arranged alphabetically in Table 4. These range in length from the one-letter word "a" to the eight-letter word "children." In the selection of this list, words which might be read as reversals were avoided.

TABLE 4
LIST OF EIGHTY-ONE WORDS USED IN TACHISTOSCOPIC
EXPOSURE, ARRANGED ALPHABETICALLY

a	had	says
and	he	school
apples	her	see
are	his	she
at	home	sleep
away	house	small
back	in	that
big	into	the
birds	is	them
blue	it	then
boy	jump	there
brown	like	they
called	look	three
came	man	to
cat	many	toys
children	me	tree
doll	more	two
eggs	morning	under
fast	mother	up
father	my	us
find	one	walk
food	pig	want
give	play	way
go	pretty	we
going	ran	what
good	red	yes
green	run	your

The selection of these particular words was influenced to a certain extent by the ease with which they fitted into a pattern

¹Clarence R. Stone, Better Primary Reading, pp. 50-53.
St. Louis: Webster Publishing Co., 1936.

of successively longer meaningful phrases for exposure. The materials finally prepared for this purpose are shown in Table 5. No word appears more than once in the list of words and phrases. It will be noted, too, that the symbols □ and +, and the letters "i" and "o," appear at the head of the list. These were included for practice purposes in order that the subject might become

TABLE 5
MATERIALS USED IN TACHISTOSCOPIC EXPOSURE,
ARRANGED IN ORDER OF INCREASING LENGTH

Number of Letter Spaces	Materials Exposed	Number of Words
1	+	-
1	□	-
1	i	-
1	o	-
2	me	1
2	us	1
3	see	1
3	had	1
4	fast	1
4	what	1
5	going	1
6	pretty	1
7	jump up	2
8	good boy	2
9	small pig	2
10	it is blue	3
11	he says yes	3
12	find his way	3
13	your big doll	3
14	two red apples	3
15	we want to play	4
16	her cat ran away	4
17	then go back home	4
18	she called one man	4
19	give them more food	4
20	there are many birds	4
21	children like my toys	4
22	father and mother came	4
23	walk under a green tree	5
24	look at three brown eggs	5
25	they sleep in the morning	5
26	run into that school house	5

accustomed to the apparatus before the exposure of words and phrases began. The materials exposed ranged from one to twenty-six letter spaces in length and were arranged according to increasing length in order to test the subject's power to apprehend

a successively longer span of material. The materials as they were centered and printed upon a white linen strip for exposure in the tachistoscope are shown in Appendix I. The type is the same as that of the selection used for the eye-movement photography.

Instrumentation.--The portable tachistoscope used in the study was manufactured by C. H. Stoelting Company for experimental purposes. It is manually operated, exposures being made through an aperture of $2 \frac{5}{32}$ inches by $\frac{3}{8}$ inches in a dulled aluminum shield 5 inches by 10 inches. The face of the apparatus may be tilted at any angle convenient for reading.

Exposure of material is effected by the pincer action of the two metal blades which comprise the shutter. This type of tachistoscope has an advantage over some types in that when material is centered in the exposure aperture, the upper and lower halves of the material are exposed at the same instant. The speed of exposure as measured at the educational psychology laboratory of the University of Chicago was $\frac{3}{30}$ or .1 seconds. This exposure period meets with Dodge's requirements, namely, that since the average reaction time of the eye is over 150 σ and since a short "clearing-up period" of probably not less than 100 σ is necessary between fixations, an exposure of 100 σ would insure "what is physiologically a single visual act."¹

The exposure material, printed upon an endless white linen strip, was advanced a line at a time by means of a lever which engaged successive perforations at the edge of the strip. A second lever, located on the same side of the instrument and just below the lever for advancing the materials, released the shutter. It was thus possible to advance the materials and release the shutter with one hand. Release of the shutter was accompanied by a fairly sharp clicking noise of the shutter blades.

Illumination of the exposed material was direct and constant, being supplied by a 60-watt daylight lamp directly in front of and above the tachistoscope, which was tilted at approximately a sixty-five degree angle. The lamp was sufficiently high so as not to interfere with a clear view of the exposure aperture. The aluminum face of the tachistoscope was masked with dull black, glare-absorbing paper in order to reduce glare to a minimum.

¹Op. cit., p. 33.

Techniques.--Subjects sat to the left and at right angles to the operator, who operated the tachistoscope with his left hand and recorded errors on a prepared form with his right hand. The attention of the subject was first directed to the symbol in the open exposure aperture. The aperture was then closed and the subject instructed to watch carefully while the same symbol was momentarily exposed. Such exposures of the initial symbol and the three succeeding test items were repeated until the operator was satisfied that the subject was directing his full attention to the center of the exposure area. Words were then exposed, with no repetitions of the same exposure, and with a uniform interval of approximately three seconds between exposures. The subjects were warned approximately one second before the actual exposure by the command "Ready."

Responses of the subjects were oral. Errors were jotted down on the record form in a previously devised "shorthand" by the operator, in the great majority of cases without prolonging the interval between exposures. Preliminary trials had shown, furthermore, that frequently a subject would make an error on just one exposure and then read several thereafter accurately. Accordingly, the scoring procedure was adjusted so that exposures were continued until the subject made two consecutive errors in his perception. The number of letter spaces which he read correctly up to the exposures containing the two consecutive errors in reading constituted his score or his span of perception for these materials.

3. The Telebinocular Examination

Materials and instrumentation.--The series of visual tests described in the Appendix of Betts' book, The Prevention and Correction of Reading Difficulties, has been widely advocated for examination of the eyes in connection with the study of reading ability. This type of examination has certain advantages over mere examination of visual acuity such as is afforded by the Snellen chart. By the use of stereoscopic techniques a quick examination may be made of several different types of visual abilities which ordinarily cannot be made by a school diagnostician or psychologist. The usual series of Telebinocular tests, known as the DB series, consists of a series of thirteen stereoscopic slides designed merely to screen out those cases of visual disability which obviously need correction. It is not claimed that this

series of tests constitutes a highly refined diagnosis of vision such as the eye specialist alone is competent to make. Inasmuch as the Telebinocular tests have been widely used as preliminary diagnostic instruments in schools, and inasmuch as a short test of this nature was alone feasible for this study, certain of these tests were chosen for use in the present investigation.

The slides used in the Telebinocular examination were standard materials prepared for that instrument. The following cards were used in this study in the order given:

1. DB-10, a test for gross binocular vision.
2. DB-1, -2, -3, tests for binocular, right, and left vision, respectively, at the far point.
3. DB-8, a test for vertical imbalance.
4. DB-6, a gross measure of the amount of stereopsis necessary for normal vision.
5. DC-1 to DC-21, a set of eleven cards, odd-numbered, designed to measure the percentage of stereopsis more accurately than the DB-6 card in percentages of 1 per cent, 10 per cent, and thereafter in intervals of 10 per cent up to 100 per cent.
6. DB-9, a test for lateral imbalance at the near point.
7. PF-1 to PF-16, a set of eight cards, even-numbered, designed to measure percentage of fusion at the near point in intervals of 10 per cent from 30 to 100 per cent fusional ability.
8. DB-7F and DB-7G, two cards to measure ametropia or sharpness of image at the near point.
9. DB-7C and DB-7D, two cards to measure ametropia or sharpness of image at the far point.

It will be noted that this series of cards departs from the DB series used in the usual minimum screening examination in two ways: (1) more precise measures of stereopsis and fusion ability are introduced, and (2) two cards designed to measure vertical imbalance and fusional ability, respectively, at the far point were omitted since this study is primarily concerned with factors affecting reading ability at the near point or reading distance. A more exact measure of stereopsis was likewise desired inasmuch as the DB-6 card measures only up to 50 per cent of possible stereopsis, according to the manual of directions issued for use

with the DB series of slides. Similarly, the card used in the DB series for measurement of fusional ability at the near point actually measures about 90 per cent fusion ability. according to representatives of the Keystone View Company, manufacturers of the Telebinocular equipment.

Techniques.--With the exception of the DC stereopsis series of cards, results were scored according to prescribed techniques on record forms prepared for the purpose. In the case of the stereopsis series, considerable confusion was encountered in choosing the proper setting of the slide holder and also the method of scoring. The Orthoptists Handbook,¹ for example, suggests that the correct procedure is to set the slide holder at infinity and have the subject read successive cards until he fails all three of the test items on a given card. If the subject passes one of the three items on a single card, according to this procedure, he is credited with passing the test. Representatives of the Keystone View Company, on the other hand, pointed out that this series of cards was originally designed for reading at 1.25 diopters distance and not at infinity. They suggested that the slide holder be set at this distance and that the subject be scored as passing a card only when he had passed all three items on a card successfully, the assumption being that at this distance a subject with normal vision should be able to pass three items on a card as easily as one item on the card when the latter was set at infinity.

Because of this discrepancy in methods advocated, the operator had all subjects read cards at the distance of 1.25 diopters until all items on two successive cards were failed. Early results showed much discrepancy in the scores between the DB-6 card and the DC series when the latter was scored by the method recommended by the representatives of the Keystone View Company. Accordingly, the procedure of crediting the highest card upon which a single item was passed, when scored according to the method suggested above, was adopted.

¹Manual of Keystone Orthoptic Exercises, Part III: The Orthoptists Handbook, p. 60. Meadville, Pennsylvania: Keystone View Co., 1935.

4. The Speed of Association

The problem.--In chapter 11, it was pointed out that Traxler¹ had found a low but positive correlation between rate of reading and speed of association. Traxler used standard speed of reading tests and free association techniques to secure measures of reaction times to two types of materials, synonyms and antonyms. The results of his experiment led Traxler to believe that persons vary considerably in the speed with which they associate ideas and that this factor affects the speed with which they read. More recently, Bear and Odbert² performed two experiments, in the first of which they repeated Traxler's study, and in the second of which they improved upon his technique of measuring speed of association while retaining the same materials. Their experiments yielded lower positive correlation coefficients between rate of reading and speed of association than those secured by Traxler. This caused Bear and Odbert to question the exact nature and extent of relationship between the factors under investigation. However, since as C. T. Gray,³ Buswell,⁴ and others have pointed out, the span of recognition increases with more rapid reading, there seems to be some justification for the proposition that there may be a positive correlation between speed of association of ideas and the span of recognition.

The use of the free association technique in measuring speed of association is open to some criticism on the ground that considerable emotional blocking may be involved when a subject attempts to give a synonym or antonym in response to a stimulus word. Free association, in fact, has been used primarily for the purpose of identifying those words or ideas which cause emotional blocking in subjects. Accordingly, it was felt that this technique should be avoided in the present study in favor of the adoption of a definite answer, "Yes" or "No," to show that the subject had completed a thought in his reading. Speed of association, therefore, as defined for the purpose of this study, indicates the rate at

¹Op. cit.

²R. M. Bear and H. S. Odbert, "Experimental Studies of the Relation between Rate of Reading and the Speed of Association," Journal of Psychology, X (July, 1940), 141-47.

³Op. cit., p. 136.

⁴Remedial Reading at the College and Adult Levels, p. 11.

which a person completes a simple thought by associating an idea aroused by a given visual symbol with another.

Materials.--The verbal materials used to measure speed of association are shown in Table 6. The materials were developed with these requirements in mind: to select a series of simple reading situations, each containing (1) a subject and (2) an object (or predicate noun or adjective). The idea represented by

TABLE 6

VERBAL MATERIALS USED IN THE MEASUREMENT OF SPEED OF ASSOCIATION, ARRANGED ACCORDING TO INCREASING LENGTH OF LINE WHEN SET IN TYPE

Materials	No. of Letter Spaces	Materials	No. of Letter Spaces
Books have pages (<u>sample</u>)	16	Meat is rope (<u>sample</u>)	12
Ice is cold.....	11	Ants are small.....	14
Fire is hot.....	11	Sugar is sweet.....	14
Day is grass.....	12	Girls have eyes....	15
Water is dry.....	12	Cows are plants....	15
Dogs are cats.....	13	Balls are round....	15
Pies are food.....	13	Hands have toes....	15
Snow is white.....	13	Dolls are streets..	17
Goats are fish.....	14	Birds have nests...	16
Arms are legs.....	13	Trees have wings...	16
Bread is drink.....	14	Houses have rooms..	17

the subject is joined by the simple connectives "is," "are," or "have" to that represented by the complement of the verb, the whole sentence thus forming a complete thought. Each complete thought or sentence so formed is obviously true or false. Thus in order for a person to make the correct response "Yes" to the statement "Ice is cold," he must by associating the idea of ice with that of coldness, show that he has read and understood the sentence.

Of the forty words other than the connectives used as materials, thirty-seven are in the first five hundred words of

Gates' primary list,¹ while the remaining three fall in the first thousand words of the same list. No words other than the connectives occur more than once. The connective "is" occurs seven times, "are" eight times, and "have" five times. One-half of the twenty sentences are true; the remainder are false. The sentences, which range from eleven to seventeen letter spaces in length, are arranged in the order of increasing length. These materials were printed in the same type size as the materials used in the measurement of the span of recognition and the span of perception.

For purposes of comparison, a second series of non-verbal materials were developed, consisting of pairs of pictures, one-half of which were clearly associated with each other and the other one-half of which were as clearly unrelated. These materials which were selected with permission from several primary intelligence tests were photographed to make them of comparable size and then paired together. They are reproduced in Appendix II. The situation of associating the idea represented by the first picture with that of the second is somewhat comparable to the situation presented in the case of the verbal materials. A verbal response, "Yes" or "No," was likewise required for the non-verbal series.

Instrumentation.--The apparatus used for measuring the speed of association was a speed of verbal response mechanism consisting of a double-relay circuit developed by David P. Boder of Lewis Institute and described in the Journal of Experimental Psychology.² In the present study this apparatus was used with the university students in connection with a Boder voice key into which the subject spoke in making a response to the exposed stimuli. In the testing at Mooseheart, the response was amplified by means of a 6-watt amplifying system as suggested in Boder's article, in order that a certain response would be obtained from children's voices. In the latter case, the subjects spoke into a microphone and the response was amplified greatly by a loud-speaker before which the voice key was placed.

¹Arthur I. Gates, A Reading Vocabulary for the Primary Grades. Revised and enlarged. New York: Bureau of Publications, Teachers College, Columbia University, 1935.

²David P. Boder, "A New Apparatus for Voice Control of Electric Timers," Journal of Experimental Psychology, XXVI (February, 1940), 241-47.

The stimulus materials were mounted upon a stiff cardboard sheet ten by twelve inches, so arranged that there was a double column of materials with a sample stimulus at the head of each column. The sheet of materials was then placed in a Line-a-time, a device used by typists for advancing their copy by means of a lever. A metal sheet in which a horizontal slot was cut the size of the exposure aperture was fastened in front of the Line-a-time, so that materials could be exposed line by line by pressing the lever. The materials were illuminated by a 60-watt daylight lamp placed above and in front of the exposure aperture. A sliding plate concealed one column of materials while the other was being exposed, and vice versa. The lever which was used to advance the materials line by line was adjusted to break an electric circuit by means of a switch which opened at the downstroke of the lever. This break in the circuit opened the first relay in the double-relay circuit which in turn activated the pen in an electric-driven paper-strip kymograph. Thus when a line of material was exposed, the kymograph pen moved over, returning to its original position only when the verbal response of the subject into the microphone tripped the second relay.

During the testing of the university students, a time line was recorded on the paper strip of the kymograph by means of a second pen adjusted to mark one-fifth second intervals by a metronome. Since the kymograph was driven by an excellent 60-watt synchronized motor, the time line was dispensed with for the Mooseheart testing because of the unsatisfactory amount of noise which it made. Instead, a gauge to measure the elapsed time on the kymograph was devised from the time-line metronomic marks. It was thought that the synchronized motor was so constant that error in the rate of the motor would be at a minimum.

Techniques.--The subject was seated before the microphone which was placed directly before the exposure aperture, thus enabling the subject to respond by speaking into the microphone as soon as he had read the stimulus materials. The operator sat at right angles to the subject, in order to reset the relay mechanism for successive responses with the right hand and in order to advance the materials by means of the lever with the left hand. The subject was instructed to answer "Yes" or "No" to the sample materials which were shown him at the head of each column of materials. Speaking into the microphone was practiced

several times in order to accustom the subject to the proper direction and volume of his voice necessary to trip the relay mechanism. Materials were then exposed successively with a uniform interval of approximately two seconds between the time of the subject's response and the exposure of the next materials. In each case the verbal materials were shown before the non-verbal ones. Errors in response were noted on a record form provided for the purpose.

The length of responses was measured by means of the gauge mentioned in the preceding paragraph. The gauge was further subdivided to measure tenths of a second. The average speed of association for twenty stimuli measured in tenths of a second was the method of scoring employed.

5. The Visual Form Span

The measurement of peripheral vision.---Investigators have long realized that peripheral vision plays an important part in the recognition of words and phrases. Dodge, for example, in 1907 commented upon the fact that foveal vision constituted the "core of perception," while peripheral vision "supplements the former by furnishing premonitions of coming words and phrases."¹ In the same year, Ruediger² measured the span of distinct vision for the letters "n" and "u" and found among other things that it was unrelated to the range of visual apprehension. C. T. Gray,³ who used perimetric techniques with fixation point and target consisting of small lights, reported that no differences were found in the peripheral vision of an unspecified number of good and poor readers. More recently, on the other hand, Eames⁴ has reported in a study of eighty-five educational disability cases, forty unselected pupils, and twelve normal pupils, that the educationally disabled pupils tended to have the smaller visual

¹Op. cit., p. 231.

²W. C. Ruediger, The Field of Distant Vision. Columbia University Contributions to Philosophy, Psychology, and Education, Vol. XVI, No. 1. New York: Science Press, 1907.

³Op. cit., p. 122.

⁴T. H. Eames, "Restriction of the Visual Field as Handicaps to Reading," Journal of Educational Research, XXIX (February, 1936), 460-65.

fields for black and white stimuli, while in a later study¹ he states that about one-fourth of 350 poor readers had restrictions in either the horizontal or vertical visual fields of five or more degrees.

Instrumentation and techniques.--It was felt that for the purpose of this study some measurement of the field of vision would be of value, but that the visual form field was a measure too broad in scope to be of particular significance in connection with the relatively limited area actually employed in normal reading. A more restrictive measure of form using a standard perimetric test object seemed to be more desirable, furthermore, than the use of particular letters which vary markedly in their ease of recognition. Consequently, a five-millimeter square white test object was employed in connection with a standard recording perimeter, No. 460, manufactured by the American Optical Company. Illumination was provided by overhead lighting and by a 60-watt daylight lamp placed behind and to the side of the subject.

The technique employed was to move the target from outside the field of regard toward the fixation point. The subject was asked to report the moment he could see clearly the four corners of the square target. Several preliminary trials were made until the subject consistently reported clearly seeing the four corners of the target at the same distance from the fixation point. Measurements were repeated in all cases in which there was noticeable fluctuation of the eye from the point of fixation. Measurements were then taken for the eight principal meridians of the eye. The combined measurement of the 180-degree axis of each eye was defined for the purpose of this study as the visual form span.

6. The Blind Spot

The problem.--A recent publication² reports several cases of enlargement of the blind spot in children due to other causes than disease. Brombach notes in connection with these cases that enlargement results from

¹T. H. Eames, "The Ocular Conditions of 350 Poor Readers," Journal of Educational Research, XXXII (September, 1938), 10-16.

²T. A. Brombach, Blind Spot Measurements and Remedial Reading Problems. American Optical Co., 1937.

transitory visual aphasia, the apparent reason being a desire to eliminate double vision or abnormalities in binocular perception. There is no doubt in my mind that many cases of young people present reading problems as a result of the reduced usable area between the blind spots and the fixation point. This will naturally reduce speed and efficiency of reading, due to improper perception of groups of letters and words and may produce symptoms which resemble wordblindness.¹

The introduction of this factor as one possible cause of reading inefficiency which might result in a reduced span of recognition led to the inclusion of this factor for consideration in the present study.

Instrumentation and technique.--The latest model of the Lloyd Stereo Campimeter, manufactured by the American Optical Company, was used to map out the extent of the blind spot. This instrument which induces binocular fixation thereby promotes steady fixation and thus allows accurate plotting of areas such as the blind spot which are near the point of fixation. A one-degree round white target was used for all measurements. The plotting of the blind spot was done in a darkened room with only the controlled illumination of ten foot-candles provided by the campimeter. Adequate time was allowed each subject for the accommodation of the eyes to the testing situation.

The subjects were shown the black chart paper upon which measurements were made directly and were told that the inner of the two fixation circles would appear as though it were at the bottom of a deep hole when the instrument was properly adjusted. This effect was quickly and easily discerned by most subjects. All measurements were made from the center of the blind spot outward. Initial measurements were repeated until the full cooperation of the subjects seemed assured. Measurements were taken in at least eight principal meridians and at more frequent intervals in those cases in which enlargement of the blind spot was revealed.

Reading and Intelligence Tests Used in the Study

Reading tests.--The inclusion of other aspects of reading ability and of the factor of intelligence in this study was dictated in part by the desire to verify or modify the evidence of relationship which these factors bear to the span of recognition

¹Ibid., p. 8.

as reported in the previous chapter. A further reason for their inclusion arises from the fact that verbal elements are common to each of these factors, which lends support to the assumption that a positive degree of relationship probably exists between each of these factors and the span of recognition.

Reading test scores upon standardized tests of reading rate, comprehension, paragraph comprehension, and vocabulary were secured for all students who participated in the study. In the case of the testing done at Mooseheart, these tests were administered after the period of laboratory testing by the writer and co-operating teachers.

In Grades I through VI, pupils were given the Courtis Silent Reading Test No. 2, Form 3, as a measure of rate of reading and of comprehension upon the rate selection. The New Stanford Reading Test, Form X, was also given to this group to measure paragraph comprehension and vocabulary. The latter test was given also at the ninth grade, in addition to the Traxler Silent Reading Test, Form 1, which contains a rate and comprehension section.

The reading scores in each of the reading phases mentioned above were taken in the case of the university students from the entrance examination scores of September, 1939, upon the Pressey Reading Speed and Comprehension Test and the Pressey General Reading Test.

Intelligence tests.--Test scores for all Mooseheart pupils were taken from Stanford-Binet examinations administered as a rule near the last birthday of the pupil. The scores were taken from the files of the Mooseheart Laboratory for Child Research. Where the previous record of testing showed that the last score was definitely atypical of the pupil's past intelligence scores, the score that appeared to be most typical was selected. In most cases, however, the last score was chosen for the purpose of this study.

The measure of intellectual ability used in the case of university students was their score upon the American Council Psychological Examination administered at the time of their entrance to the University.

General Conditions of the Study

At the beginning of this chapter it was stated that part of the testing was done at the University of Chicago and part at

Mooseheart, Illinois. The laboratory testing of the thirty-five university freshmen was done during the month of January, 1940. The data relating to the intelligence and reading ability of this group, however, were secured with but two exceptions from the test scores administered during Freshman Week, September, 1939. The exceptions related to one student who missed certain of the entrance examinations and thus took some of the tests in March, 1940, and to a second student who was given remedial work in reading during his first quarter of residence. In the latter case, the reading test scores were taken from alternate forms of the tests given in January, 1940, at the time of the testing for this study. Since none of the other students participating in the study with the exception of this one had any remedial instruction in reading from the time of their entrance into the university to the time of the testing for the present study, it was felt that the reading scores would suffice as an index of at least their relative ability in reading, if not indicating with exactness their absolute ability as of January, 1940.

The testing of Mooseheart students followed that of the university freshman during the months of February, March, and April, 1940. All laboratory testing was done at this time, while during the last month reading tests were administered. Data concerning intelligence were derived from recently administered Stanford-Binet examinations, since it is generally accepted that the individual examination technique gives a more reliable and accurate index of a subject's intellectual capacity than do group intelligence examinations.

A further general aspect of the administration of the present study has to do with the duplication of the laboratory conditions of testing set up at Mooseheart, Illinois, with those originally set up at the University of Chicago. Every effort was made to make the testing conditions comparable. For example, since some of the testing was conducted in a darkened room, the rooms were successfully darkened in both places, and the artificial illumination at desk height in the center of the two rooms used for the purposes of the testing was comparable within a few foot-candles as measured by a light-meter. Apparatus was set up in the same sequence in both situations and accessory illumination was carefully adjusted as to position and intensity, the latter factor being again checked by means of a light-meter. The routine

procedure outlined earlier was adhered to faithfully in both places.

Limitations in the Techniques and Procedures
Used in This Study

The discussion of the results of the study in succeeding chapters is conditioned at all times by the limitations inherent in the techniques and procedures described in this chapter for securing the data. It should be kept in mind, for example, that the technique of gathering data as in the case of speed of association was an experimental one. The procedure followed in securing data for the span of perception was likewise determined by the nature of the instruments and materials employed. Similarly, limitations with regard to the number of subjects and the use of different reading tests for different age groups are factors which merit consideration. These and other limiting factors are specifically pointed out in the body of this chapter. Full allowance of such limitations in the techniques and procedures as are discussed in this chapter must be made in succeeding chapters in order to secure a valid interpretation of the data therein presented.

CHAPTER IV

THE SPAN OF RECOGNITION: AN ANALYSIS AND COMPARISON OF THE EYE-MOVEMENT RECORDS

This chapter presents the data which were derived from an examination of the eye-movement records of the two hundred students who participated in the study. The initial purpose of the chapter is to present an analysis of the raw data thus secured. The growth of the span of recognition is then considered in connection with comparable data obtained by Buswell.¹

Data Derived from Eye-Movement Records

Table 7 presents data from the eye-movement records of the two hundred subjects of the study. Columns 1 and 2, respectively, show the average number of fixations and regressions per line for the ten lines used in the reading selection. Column 3 shows the average span of recognition in centimeters, while column 4 shows the same data in terms of words. Since the length of line was 8.9 cm. and the average number of words per line was 8.6 words, the differences in the figures for columns 3 and 4 are slight. In many cases, indeed, the figures are identical. The last column of the table was computed to show the amount of material spanned by the two most widely separated fixations that were not immediately preceded nor followed by a regressive movement.² Such a measurement suggests, when compared with the size of the average span of recognition in the adjoining columns, that at some point in their reading subjects typically have at least one much larger span of recognition than the average would indicate.

¹Fundamental Reading Habits.

²These figures were derived in the following way. The typical width of an eye-movement record was approximately 13 mm. This figure was then divided into the width of the material read, or 89 mm. In this way, the amount of material read per mm., 6.8 mm. or .68 cm., was obtained. These figures should be considered approximate figures only, since there was some variation in the width of individual eye-movement records.

TABLE 7

BASIC DATA DERIVED FROM EYE-MOVEMENT RECORDS,
ARRANGED ACCORDING TO GRADES

Subject and Grade	Average No. of Fixations per Line	Average No. of Regressions per Line	Average Span of Recognition (cm.)	Average Span of Recognition (words)	Largest Span (cm.) ^a
Grade II					
1	10.6	3.2	.8	.8	1.02
2	15.9	5.1	.6	.5	1.70
3	15.5	5.0	.6	.6	1.36
4	13.6	4.3	.7	.6	1.02
5	13.7	2.6	.6	.6	1.02
6	8.2	3.4	1.1	1.0	2.04
7	19.1	6.3	.5	.5	.68
8	16.3	4.4	.5	.5	1.36
9	16.7	5.4	.5	.5	1.02
10	12.3	3.2	.7	.7	1.70
11	14.5	5.2	.6	.6	1.02
12	23.1	7.1	.4	.4	2.04
13	19.4	6.0	.5	.4	1.36
14	15.2	3.4	.6	.6	1.02
15	8.0	2.4	1.1	1.1	2.38
16	9.3	1.2	1.0	.9	1.70
17	13.9	3.8	.6	.6	1.02
18	21.0	9.4	.4	.4	.68
19	11.7	3.4	.8	.7	1.70
Median	14.5	4.1	.6	.6	1.36
Grade III					
20	7.4	.7	1.2	1.2	1.36
21	12.0	4.1	.7	.7	1.02
22	14.1	5.2	.6	.6	1.36
23	4.5	.1	2.0	1.9	2.04
24	12.2	2.7	.7	.7	1.70
25	8.0	.6	1.1	1.1	1.36
26	16.4	3.8	.5	.5	.68
27	12.3	3.2	.7	.7	1.36
28	9.4	2.7	1.0	.9	1.02
29	13.1	4.5	.7	.7	1.36
30	11.0	3.1	.8	.8	1.70
31	7.8	3.1	1.1	1.1	1.70
32	14.8	5.7	.6	.6	1.02
33	9.8	1.7	.9	.9	1.36
34	6.8	.6	1.3	1.3	1.70
35	8.4	1.4	1.1	1.0	1.36
36	10.7	2.3	.8	.8	1.02
37	11.8	3.3	.8	.7	1.70
38	7.2	1.3	1.2	1.2	1.70
39	7.7	1.1	1.2	1.1	1.36
40	8.1	1.8	1.1	1.1	1.36
41	6.1	1.4	1.5	1.4	1.70
Median	9.5	2.5	1.0	.9	1.36

TABLE 7—Continued

Subject and Grade	Average No. of Fixations per Line	Average No. of Regressions per Line	Average Span of Recognition (cm.)	Average Span of Recognition (words)	Largest Span (cm.) ^a
Grade IV					
42	10.9	1.9	.8	.8	3.06
43	9.7	2.6	1.0	.9	1.70
44	11.8	3.4	.8	.7	1.36
45	6.3	1.1	1.4	1.4	1.36
46	8.0	1.9	1.1	1.1	1.36
47	8.3	2.4	1.1	1.0	1.36
48	8.6	2.0	1.0	1.0	1.36
49	10.0	2.3	.9	.9	1.02
50	7.8	1.8	1.1	1.1	1.36
51	8.8	2.0	1.0	1.0	1.36
52	13.4	4.7	.7	.6	.68
53	11.3	3.9	.8	.8	2.04
54	7.6	2.0	1.2	1.1	1.70
55	10.0	3.2	.9	.9	1.70
56	8.9	2.9	1.0	1.0	1.02
57	7.5	1.0	1.2	1.1	2.04
58	14.6	5.6	.6	.6	1.02
59	6.7	1.2	1.3	1.3	1.70
60	11.0	3.1	.8	.8	1.70
61	11.3	2.8	.8	.8	1.36
62	9.5	2.6	1.0	.9	1.02
63	7.7	1.7	1.2	1.1	1.70
64	5.1	.9	1.7	1.7	2.38
65	7.7	1.5	1.2	1.1	1.70
Median	8.8	2.3	1.0	1.0	1.36
Grade V					
66	8.2	1.6	1.1	1.0	1.36
67	11.8	3.2	.8	.7	1.36
68	7.1	1.6	1.3	1.2	1.36
69	6.3	.7	1.4	1.4	2.04
70	6.3	1.0	1.4	1.4	1.70
71	7.9	1.4	1.1	1.1	1.36
72	9.8	2.1	.9	.9	1.70
73	7.1	1.4	1.3	1.2	1.70
74	8.2	1.8	1.1	1.0	1.70
75	10.1	2.7	.9	.9	1.36
76	9.3	1.6	1.0	.9	1.02
77	9.2	1.7	1.0	.9	1.36
78	11.2	3.6	.8	.8	1.70
79	9.3	2.3	1.0	.9	2.04
80	10.3	3.8	.9	.8	1.36
81	9.7	2.4	1.0	.9	1.70
82	10.5	3.0	.8	.8	1.02
83	13.5	4.6	.7	.6	1.70
84	5.9	1.0	1.5	1.5	1.70
85	6.8	.9	1.3	1.3	1.70
86	8.4	3.1	1.1	1.0	2.38

TABLE 7—Continued

Subject and Grade	Average No. of Fixations per Line	Average No. of Regressions per Line	Average Span of Recognition (cm.)	Average Span of Recognition (words)	Largest Span (cm.) ^a
87	8.7	2.6	1.0	1.0	1.36
88	10.7	2.9	.8	.8	1.02
89	7.7	1.4	1.2	1.1	1.70
90	7.1	1.1	1.3	1.2	1.36
91	7.1	.7	1.3	1.2	1.70
92	7.1	1.4	1.3	1.2	1.70
93	9.4	1.7	1.0	.9	1.02
94	7.1	1.3	1.3	1.2	1.70
95	8.6	2.0	1.0	1.0	1.36
96	7.0	.5	1.3	1.2	1.36
97	9.1	3.1	1.0	.9	1.36
98	7.7	1.7	1.2	1.1	2.38
99	6.7	.7	1.3	1.3	1.36
100	7.2	1.5	1.2	1.2	1.70
Median	8.3	1.7	1.1	1.0	1.70
Grade VI					
101	6.0	.8	1.5	1.4	1.70
102	6.1	.2	1.5	1.4	1.36
103	9.5	3.4	1.0	.9	1.36
104	8.1	2.3	1.1	1.1	1.36
105	9.9	1.9	.9	.9	1.70
106	9.5	2.1	1.0	.9	1.70
107	9.0	1.4	1.0	1.0	1.36
108	6.4	1.0	1.4	1.3	1.70
109	6.7	.8	1.3	1.3	1.36
110	7.7	1.8	1.2	1.1	2.38
111	8.5	2.0	1.0	1.0	3.40
112	5.6	.2	1.6	1.5	2.04
113	9.9	1.3	.9	.9	1.02
114	8.1	2.7	1.1	1.1	1.36
115	10.9	3.3	.8	.8	1.36
116	11.5	3.4	.8	.7	1.02
117	11.6	4.3	.8	.7	1.36
118	8.0	1.3	1.1	1.1	1.36
119	6.0	1.0	1.5	1.4	3.06
120	7.5	1.5	1.2	1.1	2.38
121	8.4	2.4	1.1	1.0	1.70
122	6.4	.4	1.4	1.3	1.70
123	11.8	4.3	.8	.7	1.36
124	8.9	2.0	1.0	1.0	1.36
125	6.2	.7	1.4	1.4	1.36
126	6.5	1.3	1.4	1.3	2.04
127	9.2	2.7	1.0	.9	1.36
128	10.1	2.3	.9	.9	1.02
129	8.7	1.7	1.0	1.0	1.70
130	5.7	1.6	1.6	1.5	2.04
Median	8.4	1.8	1.1	1.05	1.36

TABLE 7—Continued

Subject and Grade	Average No. of Fixations per Line	Average No. of Regressions per Line	Average Span of Recognition (cm.)	Average Span of Recognition (words)	Largest Span (cm.) ^a
Grade IX					
131	7.0	1.1	1.3	1.2	1.70
132	6.4	.5	1.4	1.3	1.36
133	7.8	1.7	1.1	1.1	1.36
134	7.7	2.2	1.2	1.1	1.36
135	8.2	1.2	1.1	1.0	1.70
136	6.1	.5	1.5	1.4	1.70
137	8.3	1.3	1.1	1.0	2.04
138	6.6	.6	1.3	1.3	1.36
139	8.4	2.0	1.1	1.0	1.70
140	8.0	1.3	1.1	1.1	1.70
141	7.5	.8	1.2	1.1	1.70
142	5.6	.5	1.6	1.5	1.70
143	8.6	1.7	1.0	1.0	1.70
144	5.4	.6	1.6	1.6	1.70
145	7.7	1.7	1.2	1.1	1.36
146	7.5	1.4	1.2	1.1	1.36
147	5.5	.6	1.6	1.6	1.36 ^b
148	7.4	1.2	1.2	1.2	2.04
149	6.8	1.0	1.3	1.3	2.04
150	7.4	.7	1.2	1.2	1.36
151	7.2	1.1	1.2	1.2	1.70
152	5.9	.6	1.5	1.5	1.36 ^b
153	7.4	1.0	1.2	1.2	1.36
154	8.1	2.8	1.1	1.1	1.70
155	7.4	1.5	1.2	1.2	1.36
156	9.4	2.0	1.0	.9	1.70
157	5.8	1.2	1.5	1.5	3.40
158	8.8	1.6	1.0	1.0	1.36
159	6.6	.8	1.3	1.3	1.36
160	7.6	1.6	1.2	1.1	2.04
161	8.4	.5	1.1	1.0	1.36
162	5.4	.5	1.6	1.6	1.70
163	7.1	1.6	1.3	1.2	1.70
164	6.4	.8	1.4	1.3	1.36
165	6.8	1.2	1.3	1.3	2.04
Median	7.3	1.2	1.2	1.2	1.70
Grade XIII					
166	5.3	.9	1.7	1.6	2.04
167	3.9	.1	2.3	2.2	2.04 ^b
168	5.9	.2	1.5	1.5	1.70
169	4.7	.4	1.9	1.8	2.04
170	4.9	0.0	1.8	1.8	1.70 ^b
171	7.6	.8	1.2	1.1	1.36
172	6.0	.8	1.5	1.4	1.70
173	6.2	.6	1.4	1.4	1.36
174	5.9	.5	1.5	1.5	2.04
175	5.0	.2	1.7	1.7	2.72

TABLE 7—Continued

Subject and Grade	Average No. of Fixations per Line	Average No. of Regressions per Line	Average Span of Recognition (cm.)	Average Span of Recognition (words)	Largest Span (cm.) ^a
176	5.4	1.0	1.6	1.6	1.70
177	5.6	.1	1.6	1.5	1.70
178	7.1	.5	1.3	1.2	1.36
179	6.1	1.2	1.5	1.4	2.04
180	10.0	2.5	.9	.9	1.36
181	4.8	.6	1.9	1.8	2.04
182	6.2	.9	1.4	1.4	1.70
183	5.9	.5	1.5	1.5	1.70
184	4.5	.1	2.0	1.9	2.72
185	5.9	1.1	1.5	1.5	1.70
186	6.7	1.2	1.3	1.3	1.36
187	6.4	.6	1.4	1.3	1.70
188	6.5	.8	1.4	1.3	1.70
189	7.5	1.0	1.2	1.1	2.04
190	5.3	.6	1.7	1.6	2.04
191	5.5	.2	1.6	1.6	1.70
192	4.8	.2	1.9	1.8	1.70 ^b
193	5.1	.9	1.7	1.7	2.04
194	4.9	.4	1.8	1.8	2.04
195	4.7	.4	1.9	1.8	2.04
196	5.3	.5	1.7	1.6	2.04
197	6.1	.7	1.5	1.4	1.70
198	5.5	1.0	1.6	1.6	2.04
199	6.5	.8	1.4	1.3	1.36
200	6.7	.1	1.3	1.3	1.36
Median	5.7	.7	1.5	1.5	1.70

^aThe largest span refers to that span of material read which was neither immediately preceded nor immediately followed by a regressive eye-movement.

^bFive spans marked thus (b) are smaller than the average span of recognition, probably due to variations in the size of the photographic record.

Examination of Table 7 reveals wide individual differences in each of the factors represented both for the entire group studied and for each of the grades comprising the table. In the third grade, for example, subject 23 shows a maturity of span of recognition that is equalled or exceeded by only two students at the college level. Similarly, at the fourth-grade level, subject 64 excels all other students at Mooseheart, with the exception of subject 23, in the width of his span of recognition. On the other hand, subject 180, a college student, has an average span of

recognition that is below the median span of recognition for either the third or the fourth grade. In the latter case, however, the narrowness of the span can be largely explained by the fact that the student was of foreign birth, had come to the United States within a year previous to the testing, and while he had studied English for several years, had evidently not achieved proficiency in the silent reading of this language.

While the extremes of each group afford interesting comparisons, it should be pointed out that on the whole there is much overlapping of the successive groups in the average span of recognition. This overlapping will become more apparent in the discussion in the next section in which growth in span of recognition is considered. Before entering upon this topic, however, a word will be said concerning two other matters in connection with the eye-movement records.

The first of these is a rough check of comprehension of the selection read. Table 8 shows the comprehension scores which 193 subjects made upon the five questions asked them immediately

TABLE 8

DISTRIBUTION OF COMPREHENSION SCORES UPON THE EYE-MOVEMENT SELECTION FOR 193 SUBJECTS, ARRANGED ACCORDING TO GRADES

Grade	Comprehension Score					Total
	1	2	3	4	5	
II.....	1	...	5	3	10	19
III.....	...	...	1	7	14	22
IV.....	...	1	1	11	11	24
V.....	...	...	1	13	21	35
VI.....	...	1	1	9	19	30
IX.....	...	...	2	19	14	35
XIII.....	...	...	4	10	14	28
Total.....	1	2	15	72	103	193

after reading the selection. Ninety per cent of the subjects answered either four or five of the questions correctly. It is interesting to note that four college students made scores of only three correct items, a performance which is poorer than that made in all other grades except the second grade. In all likelihood

these college students read primarily for speed and not comprehension and were thus caught by very simple questions upon equally easy materials. This may explain also why the majority of ninth-grade students missed at least one of the questions. At both of these grade levels, furthermore, some students displayed a superior attitude when they realized what an easy level of difficulty the materials read represented. Such an attitude no doubt affected the degree of concentration with which they read.

The second aspect of the eye-movement records which may be commented upon is the degree of parallelism with which the eyes function together in reading. Careful examination of the eye-movement records failed to show records in which there was evidence of significant binocular inco-ordination as revealed by the failure of the eyes to track in parallel paths during reading beyond the normal limits of convergence and divergence of the eyes described by Schmidt.¹ This statement should not be interpreted to mean that in every case there was perfect binocular co-ordination of the eyes if by this is meant that proper muscle balance of the eyes obtained for all cases. The evidence of binocular co-ordination that is revealed by the eye-movement camera is merely symptomatic of an adjustment of the eyes that is adequate for the purpose of reading. Such an adjustment of the eyes may be either entirely comfortable for the subject or may be a definite source of strain.

The Growth and Development of the Span of Recognition

In order to compare the results of the present study with those obtained by Buswell,² the average number of fixations per line for each study have been combined in Table 9. Several facts become immediately apparent from the data presented in this form. In the first place, the overlapping of each grade with respect to fixation frequency is particularly clear, not only for each of the studies considered separately but for both studies taken together. A second fact to which attention should be called is the range of

¹William A. Schmidt, An Experimental Study in the Psychology of Reading, pp. 96-102. Supplementary Educational Monographs, Vol. I, No. 2. Chicago: Department of Education, University of Chicago, 1917.

²Fundamental Reading Habits.

TABLE 9
COMPARISON OF THE DISTRIBUTION OF THE AVERAGE NUMBER OF FIXATIONS
PER LINE IN THE PRESENT STUDY (H) AND IN THAT OF BUSWELL (B)
AT SEVEN GRADE LEVELS

Average No. of Fixations per Line	Grade Level														Total	
	II		III		IV		V		VI		IX		XIII			
	H	B	H	B	H	B	H	B	H	B	H	B	H	B	H	B
3.0 - 3.9.....													1	2	1	1
4.0 - 4.9.....													7	4	8	4
5.0 - 5.9.....													13	6	23	13
6.0 - 6.9.....		2	....	....	....	....	....	....	....	....	....	....	10	....	33	28
7.0 - 7.9.....													3	....	38	19
8.0 - 8.9.....															30	13
9.0 - 9.9.....															19	10
10.0 - 10.9.....															12	10
11.0 - 11.9.....															12	15
12.0 - 12.9.....															4	2
13.0 - 13.9.....															6	2
14.0 - 14.9.....															4	0
15.0 - 15.9.....															3	0
16.0 - 16.9.....															3	0
17.0 - 17.9.....																0
18.0 - 18.9.....																0
19.0 - 19.9.....																0
20.0 - up.....																0
Total.....	19	18	22	15	24	15	35	16	30	19	35	12	35	13	200	108
Median.....	14.5	10.7	9.5	8.9	8.8	7.3	8.3	6.9	8.4	7.3	7.3	5.8	5.7	5.9	....	....

scores for each grade. It will be noted that this range is uniformly greater in the case of the present study at each grade level except the ninth grade. This may probably be explained as a result of the smaller number of students per grade used by Buswell, as well as by the fact that in his study only those students who were considered typical of their respective grade levels were selected. It will be remembered also that in the first five grades used in the present study all pupils except a small group of the most severely retarded were tested, but in the ninth grade a group of students nearest the expected age for that grade were selected. The ninth-grade students tested by Buswell showed but a slightly wider range of average fixation frequency even though they represented only about one-third of the number of students employed in this study.

A third type of information shown in Table 9 is that revealed by a comparison of the median scores for average fixation frequency at each grade level. It will be noted that Buswell's group tends to show superior reading ability when measured by this criterion with the exception of a very slight advantage in favor of the students of the present study at the college level. The general superiority of the former group is no doubt largely to be explained by differences in the bases of selection employed in the two studies, as well as to the fact that there is large probability that the earlier study utilized a generally superior group of students.

The tendency of the average fixation frequency to decrease grade by grade and thereby increase the average span of recognition is more graphically brought out by Figure 1. In this figure the curves are based upon the median scores per grade for average fixation frequency per line. The average superiority of Buswell's group becomes even more apparent here. Of especial significance, however, is the marked similarity of the two curves. Both curves accelerate fairly sharply from the second to the third grades. This acceleration is continued to the fourth grade in Buswell's group before entering upon a plateau which extends through the sixth grade. In the present study the plateau begins at the third grade. Very slight acceleration occurs in both curves in the middle of the plateau between Grades IV and V. Both curves also show approximately the same amount of acceleration in the curve from the sixth to the ninth grade, followed by a slight

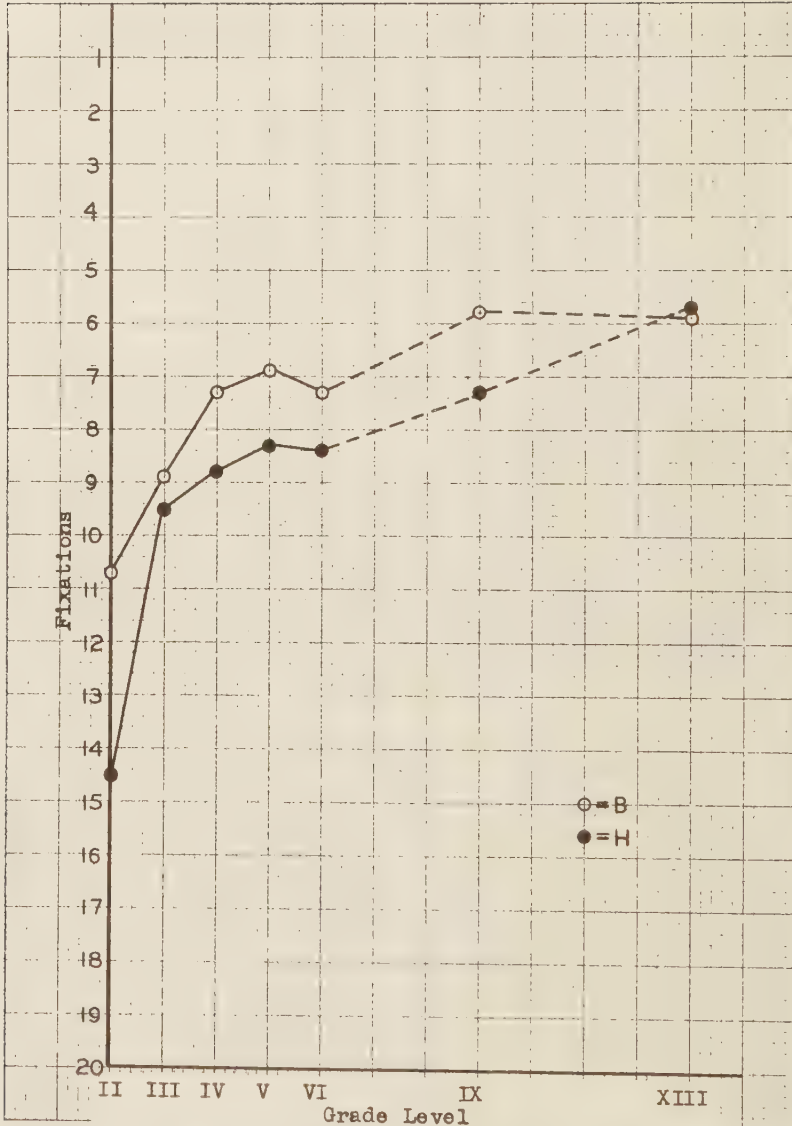


Fig. 1.--Comparison of median scores for the average number of fixations per line in the present study (H) and in that of Buswell (B) at seven grade levels.

decrease in the case of Buswell's group but by a definite increase in the present study from the ninth to the thirteenth grade. It seems entirely probable that the relative positions of the median scores made by Buswell's subjects at the latter grade levels are in part at least a function of the small number of cases used.

The data for the present study have been also arranged in Table 10 according to the average size of the span of recognition

TABLE 10
DISTRIBUTION OF THE AVERAGE SIZE OF THE SPAN OF RECOGNITION
AT SEVEN GRADE LEVELS

Average Size of Span of Recognition	Grade Level							Total
cm.	II	III	IV	V	VI	IX	XIII	
2.3.....	...	...	...	...	...	...	1	1
2.2.....	...	...	...	...	...	...	...	0
2.1.....	...	...	...	...	...	...	...	0
2.0.....	...	1	...	...	...	...	1	2
1.9.....	...	...	...	...	...	...	4	4
1.8.....	...	...	...	...	...	...	2	2
1.7.....	...	...	1	...	...	...	5	6
1.6.....	...	...	...	...	2	4	4	10
1.5.....	...	1	...	1	3	3	7	15
1.4.....	...	...	1	2	4	2	5	14
1.3.....	...	1	1	9	1	6	3	21
1.2.....	...	2	4	3	2	10	2	23
1.1.....	2	5	3	4	4	7	...	25
1.0.....	1	1	5	8	7	3	...	25
.9.....	...	1	2	3	3	...	1	10
.8.....	2	3	5	4	4	...	...	18
.7.....	2	4	1	1	...	...	...	8
.6.....	6	2	1	...	...	...	...	9
.5.....	4	1	...	...	...	...	...	5
.4.....	3	...	...	...	...	...	...	2
Total.....	19	22	24	35	30	35	35	200
Median.....	.6	1.0	1.0	1.1	1.1	1.2	1.5	...

while the median scores based on the same data are presented graphically in Figure 2. Those observations made concerning the average number of fixations per line with respect to overlapping, range, and general growth trends are likewise pertinent here, since the span of recognition is a function of the number of fixations per line. Differences in the unit of measurement account for the differences in the distribution of the data.

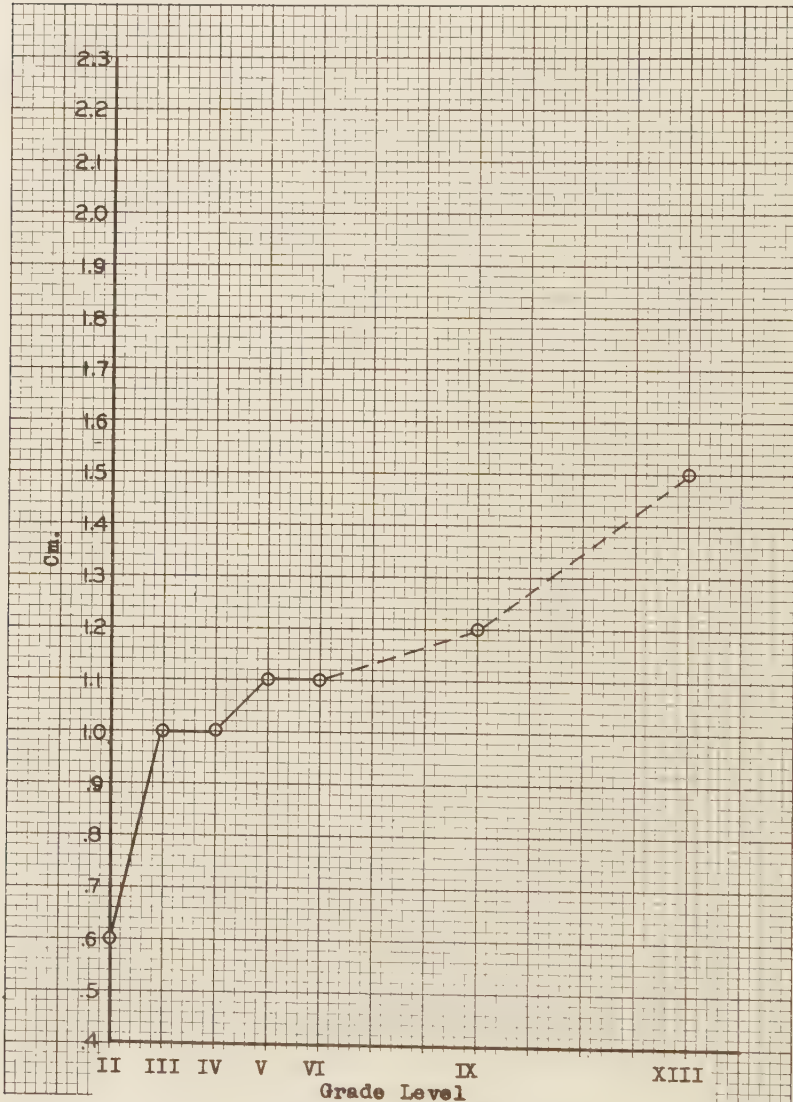


Fig. 2.--Median scores for the average size of the span of recognition at seven grade levels.

Two observations may be made with respect to the data presented in this form. The first has to do with differences in the average span of recognition at various grade levels. While the ranges for each grade shown in Table 10 are great, nevertheless the average span of recognition for the median student is only .6 centimeters in the second grade and 1.5 centimeters in the thirteenth grade. Furthermore, there is singularly little difference in the median span for the second and the ninth grades. The average span of recognition for the median university student is less than three times as large as that for the median second-grade student. In other words, the latter student uses on the average a span sufficiently wide to encompass syllables only or a short three-letter word such as "are," while the median college student reads on the average seven- or eight-letter words such as "morning" or "children" at a glance in continuous reading. The median college student, then, reading materials far below his level of difficulty utilizes only a span of recognition equivalent to two or possibly three syllables, to a single word of moderate length only, or to phrases that must be very narrow in scope indeed.

The second observation relates to the growth curve of the span of recognition shown in Figure 2. In general, the shape of the curve is very much like that in Figure 1. The arrangement of data in terms of width of span serves to accentuate the difference in growth between the ninth and the thirteenth grades more than between the second and the third grades. The plateau during the period of the middle grades is easily distinguishable. In all probability, however, the similarities between the curves in Figure 1 and Figure 2 are more important than the observed differences.

The data which have been presented thus far show that for the group as a whole there is a tendency for the span of recognition to broaden markedly from the second to the third grade and then to change but slightly during the period of the middle grades. It seems reasonable to assume that, as in many other learning processes, the initial growth of the habit is rapid. The subsequent less rapid growth of the span of recognition during the middle-grade period may be explained, it appears to the writer, in one or more of the following ways: (1) early gains tend to become crystallized into a habit that is adequate for current needs; (2) many new and exacting demands are made upon the reader

at this time, thus restricting development in the span of recognition; or (3) progress in development of the span of recognition tends to slow down as the span approaches its greatest expected breadth.

However, by the ninth grade further progress has been made in broadening the span, a trend which is continued in the group data for the present study at least, through the first-year university level. The growth trends observed by Buswell have thus for the most part been confirmed by the present study.

Summary

The data for this study show that the initial rapid growth of the span of recognition tends to slow down during the middle elementary period at which time the total reading habit is undergoing extensive reorganization and adjustment. A definite increase in the average span of recognition is noted by the time the student reaches the ninth grade, and in the present study, a similar increase obtains at the thirteenth grade or the beginning level of higher education. A significant fact, however, which is brought out in the consideration of the development of the span of recognition is that even at the beginning of the period of higher education, the span of the median student is still a relatively narrow one, such that he reads with an average span of recognition broad enough only to encompass words or small phrases of a total of seven or eight letters of the size of type used in this study. Considering the degree of difficulty of the selection read, the width of the span of recognition of such a student hardly indicates that he reads in units of the complete phrase, but rather of the word or parts of phrases.

However, it is worthy of note that the span of recognition is a factor subject to growth and that within each grade level there is evidence of wide variation in the degree of growth achieved. This indicates that there is hope that with improved methods of teaching reading, more students may approach and exceed the grade medians secured for this study. There is also hope that more students will likewise approach their maximum possible development in the span of recognition early in their careers at school, as some students have apparently done according to the results of the present study.

CHAPTER V

THE RELATION OF SELECTED PSYCHOLOGICAL AND PHYSIOLOGICAL FACTORS TO THE SPAN OF RECOGNITION

In this chapter, the correlation of each of the factors studied in relation to the span of recognition will be considered. It is proposed to discuss first two measures derived from the eye-movement records, namely, regression frequency and rate of reading as derived from the length of the eye-movement record; second, the non-laboratory factors of the study, intelligence and reading ability as measured by standardized tests; and third, those factors of both a psychological and a physiological nature studied by means of laboratory techniques. Since a discussion of the raw data and their representation in tabular form unnecessarily complicate the consideration of the relationship found between these factors and the span of recognition, the distribution of such data has been condensed in a series of tables which appear in Appendix III.

The Relation of Evidence from Eye-Movement Data to the Span of Recognition

Regression frequency.--The calculation of the span of recognition, according to standard procedure, is based upon fixations of the eyes that result from both the forward and regressive movements of the eyes. As a result, a correlation of regression frequency with a measure which includes regressions would produce a biased correlation. In order to secure a more accurate picture of the relationship between the span of recognition and regression frequency, the latter factor was correlated with the average number of fixations made in the forward movements only of the eyes. The results of this correlation analysis are shown in Table 11.

At each grade level except the ninth grade, the correlation between regression frequency and the frequency of the forward

fixations of the eyes is significant.¹ Each correlation is likewise positive. These results indicate that there is a tendency for a decrease in the number of forward fixations of the eyes to be accompanied by a decrease in the number of regressive movements. This may be interpreted to mean that a broadening of the span of recognition tends to be associated with a decrease in regression frequency.

TABLE 11

RELATION OF AVERAGE REGRESSION FREQUENCY TO THE AVERAGE
FREQUENCY OF FORWARD FIXATIONS OF THE EYES,
ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	.679	+.081	19
III.....	.673	+.081	22
IV.....	.678	+.073	24
V.....	.549	+.081	35
VI.....	.428	+.094	30
IX.....	.174	+.110	35
XIII.....	.467	+.088	35
Total.....	....	....	200

Length of the eye-movement record: a measure of rate of reading.--The length of the eye-movement record provides an index of rate of reading, since, as Tinker has shown, perception time involved in reading an eye-movement selection represents over 90 per cent of the entire time spent in the act of reading.² Thus a long eye-movement record would indicate slow reading; a short one, fast reading. The correlation coefficients showing the relationship between this factor and the span of recognition are given in Table 12. The coefficients are all significant and are higher than those obtained for regression frequency. The negative correlation coefficients indicate a tendency toward a close correspond-

¹Correlation coefficients that are three times their probable error are considered significant in this study.

²M. A. Tinker, "Eye Movement Duration, Pause Duration, and Reading Time," Psychological Review, XXXV (September, 1928), 394.

ence between a wide span of recognition and a rapid rate of reading as measured by the length of the eye-movement record.

Of all the factors included in this study, the most uniformly high coefficients were secured for the two factors which have just been described, namely, regression frequency and the length of the eye-movement record. The consistency of the relationship between rate of reading as measured by the eye-movement record and the span of recognition is especially noteworthy in view of the fact that for none of the other factors studied were significant correlation coefficients obtained at all grade levels.

TABLE 12

RELATION OF RATE OF READING AS MEASURED BY THE LENGTH OF THE EYE-MOVEMENT SELECTION TO THE SPAN OF RECOGNITION, ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	-.722	±.073	19
III.....	-.795	±.054	22
IV.....	-.860	±.035	24
V.....	-.882	±.026	35
VI.....	-.822	±.040	30
IX.....	-.585	±.076	35
XIII.....	-.804	±.041	35
Total.....	....	....	200

The Relation of Intelligence and of Reading Ability to the Span of Recognition

Because of wide differences in intellectual maturity and in the reading ability of the students, different tests were necessarily required for university students, and in some cases for ninth-grade students, than were used for testing at the lower grades. Consequently, the Mooseheart scores at the lower grade levels are the more comparable scores. In each case in which different materials were used, recognition of this fact will be made in the tables.

Intelligence.--Correlation coefficients for the intelligence test scores and the span of recognition per grade are given

in Table 13. The correlation coefficients are positive with the exception of the coefficient for the second grade, while those for the third, fourth, sixth, and thirteenth grade are significant. The degree of relationship in these grades corresponds favorably to that found by Leavell and Sterling¹ at the sixth-grade level.

TABLE 13
RELATION OF INTELLIGENCE TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES*

Grade	Correlation Coefficient	P.E.	N
II.....	-.205	±.144	19
III.....	.387	±.129	22
IV.....	.427	±.111	24
V.....	.195	±.109	35
VI.....	.534	±.081	30
IX.....	.064	±.123	35
XIII.....	.437	±.092	35
Total.....	....	....	200

*Grades II through IX: Stanford-Binet Test; Grade XIII: American Council Psychological Examination.

The lack of a positive correlation at the second-grade level may be merely indicative of the fact that at this stage the differences between readers are not significantly associated with differences in intellectual ability as measured by mental ages. Above this level, however, the evidence suggests some correspondence between these two factors. The very low coefficients at the fifth- and ninth-grade levels are not in line with this trend, however, and may be due to other complicating factors.

Reading rate.--Table 14 shows the correlation coefficients for rate of reading as measured by standardized tests and the span of recognition. The coefficients are significant in Grades III through VI, but in the second grade the coefficient is negative as was the case in the correlation of intelligence with the span of recognition. At the ninth-grade level the correlation coefficient

¹Op. cit. The correlation coefficient cited by Leavell and Sterling is .36 ± .04.

is positive but not high enough to be significant. However, a significant correlation coefficient is again found at the thirteenth-grade level. This evidence shows that rate of reading tends to be slightly more closely associated with span of recognition than does intelligence, and in this respect confirms

TABLE 14
RELATION OF READING RATE TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES*

Grade	Correlation Coefficient	P.E.	N
II.....	-.188	±.146	18
III.....	.719	±.073	22
IV.....	.701	±.069	24
V.....	.625	±.070	35
VI.....	.438	±.109	23
IX.....	.272	±.105	35
XIII.....	.573	±.076	35
Total .....	....	....	192

*Grades II through VI: Courtis Silent Reading Test; Grade IX: Traxler Silent Reading Test; Grade XIII: Pressey Reading Speed and Comprehension Test.

the results obtained in correlating reading rate as measured by the length of the eye-movement record with the span of recognition shown in Table 12.

Since rate of reading was thus secured in two ways for this study, these two measures of rate of reading were correlated. The results of this correlation are presented in Table 15. The correlation coefficients here too are significant at all levels except the second and ninth grades. The fact that the significant correlation coefficients are negative indicates that those students who read the eye-movement selection fast and thus secured short records likewise tended to read fast on the standardized reading tests, and vice versa.

Reading comprehension.--Reading comprehension in each of the tests administered was measured upon the same selection used to test rate of reading. Correlation coefficients at each grade

TABLE 15

RELATION OF READING RATE AS MEASURED BY THE LENGTH OF THE EYE-MOVEMENT RECORD TO THAT MEASURED BY STANDARDIZED TESTS, ARRANGED ACCORDING TO GRADES*

Grade	Correlation Coefficient	P.E.	N
II.....	.050	±.151	18
III.....	-.722	±.073	22
IV.....	-.634	±.080	24
V.....	-.663	±.064	35
VI.....	-.393	±.113	23
IX.....	-.180	±.110	35
XIII.....	-.677	±.061	35
Total.....	....	....	192

*Correlations with the length of the eye-movement record were made with the following tests: Grades II through VI: Courtis Silent Reading Test; Grade IX: Traxler Silent Reading Test; Grade XIII: Pressey Speed and Comprehension Test.

level for reading comprehension and span of recognition are given in Table 16. While in every case the correlation is positive, at only three levels--the third, fourth, and thirteenth grades--are significant coefficients found. The inconclusiveness of these

TABLE 16

RELATION OF READING COMPREHENSION ON THE RATE SELECTION TO THE SPAN OF RECOGNITION, ARRANGED ACCORDING TO GRADES*

Grade	Correlation Coefficient	P.E.	N
II.....	.214	±.142	18
III.....	.647	±.089	22
IV.....	.628	±.083	24
V.....	.286	±.105	35
VI.....	.067	±.134	23
IX.....	.116	±.112	35
XIII.....	.337	±.101	35
Total.....	....	....	192

*Grades II through VI: Courtis Silent Reading Test; Grade IX: Traxler Silent Reading Test; Grade XIII: Pressey Speed and Comprehension Test.

findings raises some doubt as to the exact degree of association between comprehension as measured in this way and the size of the recognition unit in reading.

Paragraph comprehension.--Table 17 shows the relationship between paragraph comprehension and the span of recognition. With the exception of the ninth grade, the correlation coefficients are all positive and significant, thus indicating some tendency for the two factors to be associated. The consistency of the relationship between these factors at each of the several grade levels

TABLE 17

RELATION OF PARAGRAPH COMPREHENSION TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES^a

Grade	Correlation Coefficient	P.E.	N
II.....	.440	±.122	18
III.....	.793	±.054	22
IV.....	.498	±.101	24
V.....	.453	±.090	33
VI.....	.549	±.087	28
IX.....	-.099) .287 ^b)	±.113) ±.105 ^b)	35
XIII.....	.358	±.099	35
Total.....	....	....	195

^aGrades II through IX: New Stanford Reading Test; Grade XIII: Pressey General Reading Test.

^bTraxler Silent Reading Test.

is greater than for any of the other factors studied, except regression frequency and rate of reading as measured by the length of the eye-movement record. Even at the ninth-grade level, a positive correlation coefficient of .287 ±.105 was secured between the paragraph comprehension section of the Traxler Speed of Silent Reading Test and the span of recognition.

Word meaning.--The relationship between word meaning and the span of recognition is indicated by the correlation coefficients in Table 18. While each correlation coefficient is positive, there appears to be little more consistency from grade level to grade level than was found between intelligence and the span of

recognition. Both intelligence and word meaning are correlated positively and significantly with the span of recognition at the same grade levels only.

TABLE 18
RELATION OF WORD MEANING TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES^a

Grade	Correlation Coefficient	P.E.	N
II.....	.337	±.133	18
III.....	.673	±.081	22
IV.....	.364	±.117	24
V.....	.238	±.107	33
VI.....	.615	±.076	28
IX.....	.092) .120 ^b)	±.113) ±.113 ^b)	35
XIII.....	.472	±.088	35
Total.....	....	....	195

^aGrades II through IX: New Stanford Reading Test; Grade XIII: Pressey General Reading Test.

^bTraxler Silent Reading Test.

Résumé.--The discussion of the relation of intelligence and reading ability to the span of recognition in the preceding paragraphs has been confined primarily to a consideration of the extent to which the correlation coefficients were significant. The results of this discussion may be summarized and clarified further by reference to Table 19. This table shows the number of positive correlation coefficients for each factor as well as the number of such correlation coefficients which were significant. The rank order of the significant relationship of the factors to the span of recognition, as indicated by the column marked "Difference," is as follows: paragraph comprehension, reading rate, intelligence, word meaning, and comprehension upon the rate selection. While this order of relationship is probably not invariable, nevertheless it is suggestive of the relative importance of certain intellectual abilities which tend to be associated with differences in the span of recognition in reading.

TABLE 19

EXTENT OF POSITIVE RELATIONSHIP OF INTELLIGENCE AND
READING ABILITY TO THE SPAN OF RECOGNITION

Factors Correlated with the Span of Recognition	No. of Positive Cor- relation Coefficients, with No. of Negative Coefficients in Parentheses	No. of Sig- nificant Positive Correlation Coefficients	Dif- ference
Intelligence.....	6 (1)	4	2
Reading rate.....	6 (1)	5	1
Reading compre- hension.....	7	3	4
Comprehension.....	6* (1)	6	0
Word meaning.....	7	4	3
Total.....	32+(3)=35	22	....

*This figure includes the negative correlation found at the ninth-grade level between comprehension on the New Stanford Reading Test and the span of recognition. A positive correlation, however, was found between this latter factor and comprehension as measured by the Traxler Silent Reading Test.

The Relation of Factors Measured by Laboratory
Techniques to the Span of Recognition

1. The Span of Perception

It will be recalled that the technique used in measuring the span of perception was to present a series of increasingly longer materials until the subject failed two successive exposures. The widest span of material read under these conditions was then taken as the subject's span of perception. Correlation coefficients showing the relation of the span of perception thus measured to the span of recognition are shown in Table 20. Substantial positive coefficients were obtained at the third-, fourth-, fifth-, and sixth-grade levels. These correlation coefficients correspond favorably with those obtained by Robinson¹ and Litterer²

¹Op. cit. The correlation coefficient cited by Robinson was $.52 \pm .07$.

²Op. cit. The correlation coefficients cited by Litterer were $-.437$ and $-.383$ between fixation frequency and the span of perception.

at the college level.

A lower correlation coefficient, however, was obtained in this study at the thirteenth-grade level than was found by the latter experimenters. The degree of association between these two factors at this level was doubtless affected in part by the performance of two of the university subjects, numbers 166 and 174, both of whom made lower span of perception scores in this

TABLE 20

RELATION OF SPAN OF PERCEPTION TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	.090	±.149	19
III.....	.536	±.026	22
IV.....	.456	±.106	24
V.....	.439	±.092	35
VI.....	.662	±.070	30
IX.....	.209	±.109	35
XIII.....	.254	±.106	35
Total.....	....	....	200

test than the median second-grade student. In spite of several minutes of patient practice to accustom themselves to the tachistoscopic exposure, these subjects were unable to perceive more than a very limited amount of material when it was thus exposed. At the same time, however, subject 174 had a span of recognition equivalent to the median span of her group, while that of subject 166 was considerably wider than the median span of recognition at the university level.

The correlation coefficient at the ninth-grade level was not affected by such extremes, yet the figure obtained was not high enough to be significant. At both this and the thirteenth-grade level, the factor of degree of difficulty of materials may have operated to keep the amount of positive association between the factors at a minimum. Thus, when ninth- and thirteenth-grade students read materials of a very low level of difficulty, it is conceivable that the scores on such materials would tend to be

bunched together rather than spread out. This tendency would act to lower the degree of relationship observed. Reference to Table 48 in Appendix III will show that at both the ninth- and the thirteenth-grade levels there is a distinct grouping of scores at one point. This grouping of scores may also be due to a certain extent, of course, to differences in the degree of difficulty between materials in successive exposures.

At the second-grade level a positive but negligible correlation coefficient also was secured. The writer was impressed during the testing of this grade with the extent to which the tachistoscope appeared to distract the subjects. In several cases the subjects apparently were more interested in anticipating the click of the shutter than in perceiving with any degree of accuracy the materials which were exposed.

Before turning to a discussion of the next factor, the fact should be pointed out that a comparison of the average size of the span of recognition for the median student at each grade level with the median span of perception showed that the latter ranges from 3.1 to slightly over 3.8 times as large as the former type of span. These differences were computed by assuming that one centimeter is equivalent to approximately three letter spaces of the size of type used in the study. These differences, furthermore, are larger than those already reported in chapter ii by Robinson¹ and Walker² who found that the span of perception on the average approximated two times the average span of recognition. It is entirely possible that the differences noted may be due largely to variations in the degree of difficulty of materials or to the types of materials employed. As was seen in an earlier chapter, the materials for measuring the span of recognition and the span of perception in the present study, however, are fairly comparable.

2. The Speed of Association

Speed of verbal association, measured by techniques outlined in chapter iii, tends to be associated with the span of recognition to the degree suggested by Table 21. The correlation coefficients are, with the exception of the indecisive one at the ninth-grade level, all negative, and all those through the sixth

¹Op. cit.

²Op. cit.

grade are significant. This would indicate considerable relationship between the speed with which one associates ideas, as measured by the time taken to respond to a complete thought unit, and the breadth of the span of recognition. Even at the thirteenth-grade level, the correlation coefficient is almost, though not quite large enough to be, significant.

TABLE 21

RELATION OF THE SPEED OF VERBAL ASSOCIATION TO THE SPAN OF RECOGNITION, ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	-.393	±.126	15
III.....	-.412	±.124	22
IV.....	-.480	±.104	23
V.....	-.493	±.086	35
VI.....	-.381	±.105	30
IX.....	.052	±.114	35
XIII.....	-.282	±.105	35
Total.....	....	....	195

When the correlation coefficients for verbal speed of association are compared with those for the speed of non-verbal association given in Table 22, several differences appear immediately. None of the correlation coefficients between speed of non-verbal association and the span of recognition are significant. Four of the correlation coefficients are negative, three positive. There appears to be no discernible trend grade by grade in the extent of positive or negative association. While a discussion of the full implications of this lack of significant relationship of non-verbal speed of association to the span of recognition will be deferred to chapter vi, it should be noted here that the latter factor does not appear to be significantly related to the breadth of the span of recognition, whereas a measure of speed of verbal association tends to be so related. It will be recalled, nevertheless, that the situations used to measure these two factors were practically identical, with the exception of the nature of the stimuli involved. Some weight is here lent to the view,

therefore, that those readers with a larger span of recognition also have faster recognition habits for the specific type of materials involved in the reading process, namely, words in a contextual situation. On the other hand, measurement of speed of association in terms of non-verbal stimuli as employed in this study apparently does not yield evidence of a comparable degree of positive relationship.

TABLE 22

RELATION OF THE SPEED OF NON-VERBAL ASSOCIATION TO THE SPAN OF RECOGNITION, ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	.157	±.147	19
III.....	-.339	±.133	22
IV.....	.157	±.131	23
V.....	-.048	±.114	35
VI.....	.027	±.123	30
IX.....	-.131	±.112	35
XIII.....	-.198	±.109	35
Total.....	....	....	199

3. Visual Defects Measured in the Telebinocular Examination

Seven tests of visual efficiency were selected, it will be recalled, for examination by means of the Telebinocular. These tests were: (1) binocular acuity, (2) fusion at the near point, (3) vertical imbalance at the near point, (4) lateral imbalance at the near point, (5) sharpness of image at the near point, (6) sharpness of image at the far point, and (7) stereopsis or depth of vision. The relation of each of these factors to the span of recognition may be readily observed in Table 23.

Of the forty-nine correlation coefficients given in this table, only six are significant. Furthermore, there is no consistency of relationship shown for any one of these factors, since only two significant correlation coefficients were found for any one factor when it was correlated with the span of recognition. With the exception of sharpness of image at the near

TABLE 23
RELATION OF SEVEN VISUAL FACTORS MEASURED BY THE TELEBINOCULAR TO THE SPAN
OF RECOGNITION, ARRANGED ACCORDING TO GRADES

Grade Level	Binocular Acuity		Fusion (Near)		Vertical Imbalance (Near)		Lateral Imbalance (Near)		Sharpness of Image (Near)		Sharpness of Image (Far)		Stereopsis		N
	r	P.E.	r	P.E.	r	P.E.	r	P.E.	r	P.E.	r	P.E.	r	P.E.	
II.....	-.032	±.151	-.422	±.124	-.184	±.228	-.426	±.206	-.218	±.144	-.239	±.142	-.057	±.151	19
III.....	.134	±.146	-.036	±.151	.605	±.206	.671	±.243	.017	±.151	-.200	±.145	.050	±.151	22
IV.....	-.084	±.134	-.475	±.104	.481	±.173	.000	±.204	-.374	±.115	-.288	±.124	-.033	±.135	24
V.....	-.128	±.112	.100	±.113	-.138	±.175	-.246	±.185	.106	±.113	.397	±.096	.322	±.102	35
VI.....	.019	±.123	.166	±.120	-.183	±.206	-.122	±.206	.026	±.123	-.026	±.123	.062	±.123	30
IX.....	-.053	±.114	.016	±.111	.313	±.159	.186	±.227	.221	±.109	.110	±.113	-.147	±.112	34*
XIII.....	.086	±.113	-.171	±.110	-.077	±.204	-.040	±.159	.043	±.114	.070	±.114	-.494	±.086	35

*One subject with injured eye omitted.

point, the number of positive and negative correlations are in most cases in the order of four negative correlations and three positive ones. Sharpness of image at the near point, however, is positively correlated with the span of recognition in five out of seven cases, although the only instance in which the correlation coefficient is significant occurs in the negative coefficient at the fourth-grade level.

The picture of relationship between these visual factors and the span of recognition is thus negative in character, indicating that the degree of association between these visual factors and at least one measure of reading ability is negligible, or, indeed, one of pure chance, when the subjects represent a wide range of reading ability for a given grade. The fact that one of the two significant coefficients for lateral imbalance and stereopsis is in each case positive while the other is negative gives additional support to this point of view. There is indeed little evidence to be derived from the data presented in Table 23 to warrant a conclusion that the results of the Telebinocular tests chosen for this study show a significant relationship to the span of recognition.

4. The Visual Form Span

Evidence of the relationship of this factor to the span of recognition is presented in Table 24. Again, as was the case in the visual factors measured by the Telebinocular tests, there is no evidence of significant association between the size of the

TABLE 24

RELATION OF THE SIZE OF THE VISUAL FORM SPAN TO THE SPAN OF RECOGNITION, ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	-.133	±.148	19
III.....	-.126	±.149	22
IV.....	.207	±.130	24
V.....	.247	±.107	35
VI.....	-.219	±.117	30
IX.....	.101	±.113	34
XIII.....	-.077	±.113	35
Total.....	....	....	199

visual form span and the span of recognition. There is likewise no evidence for either a consistent positive or negative relationship involved, since four of the coefficients are negative and three of them are positive. It must be concluded from the body of data available from this study that the amount of relatively clear vision is not significantly associated with the breadth of the recognition unit employed in continuous reading.

5. The Blind Spot

The final visual factor with which this study is concerned is the blind spot, the degree of relationship which it bears to the span of recognition being given in the correlation coefficients shown in Table 25. The relationship between this factor and the span of recognition does not differ significantly from that observed for the other visual factors which have been measured in this study. No one correlation coefficient in Table 25

TABLE 25

RELATION OF THE SIZE OF THE BLIND SPOT TO THE SPAN OF RECOGNITION, ARRANGED ACCORDING TO GRADES

Grade	Correlation Coefficient	P.E.	N
II.....	.215	±.144	19
III.....	-.057	±.150	22
IV.....	-.251	±.126	24
V.....	-.283	±.105	35
VI.....	-.269	±.115	30
IX.....	-.193	±.109	34
XIII.....	-.124	±.077	35
Total.....	....	....	199

is large enough to be significant. However, there is some indication that the size of the blind spot tends to be negatively associated with the span of recognition at all grade levels except the second grade.

Résumé of laboratory factors.--For the factors measured by laboratory techniques, there is some evidence that span of perception and speed of verbal association tend to show a positive

and often significant degree of relationship to the span of recognition. Such is not true, however, for speed of non-verbal association, nor on the whole, true for those visual factors which were studied in connection with the span of recognition.

General Relationships of Psychological Versus
Visual Factors to the Span of Recognition

In the previous sections of this chapter, the degree of relationship of selected psychological and physiological factors to the span of recognition was considered factor by factor. In order to visualize these relationships more broadly and to allow opportunity for comment about the evidence presented as a whole, Table 26¹ has been prepared to show the correlation coefficients found between all psychological factors measured, including intelligence, and the span of recognition, while Table 27² gives similar data for all visual factors studied in relation to the span of recognition.

Comparison of these tables shows that a total of ten psychological factors and nine visual factors were correlated with the span of recognition, making a total of seventy and sixty-three correlations, respectively, since correlations were made at seven grade levels. Of the seventy correlation coefficients for the psychological factors shown in Table 26, forty-four, or 63 per cent, of the coefficients are significant. On the other hand, only six of the correlation coefficients secured for the visual factors are significant, representing but 10 per cent of the total number of sixty-three coefficients for visual factors. In no case did any one visual factor consistently tend to be significantly associated with differences in the size of the span of recognition, whereas in the case of psychological factors, at the majority of grade levels and for the great majority of factors, a significant degree of association was indicated. The outstanding exception with regard to the psychological factors was, as has been indicated, the negligible results obtained in the correlation of the span of recognition with non-verbal speed of association.

¹Significant correlations, i.e., those which are at least three times their probable error, are underlined in Tables 26 and 27.

²Ibid.

TABLE 26
RELATION OF TEN PSYCHOLOGICAL FACTORS TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES

Grade Level	I Intelligence	II Standardized Reading Tests				III Span of Percep- tion	IV		V		No. of Significant Correlations	N ^b
		Reading Rate	Reading Compre- hension	Paragraph Mean- ing	Word Meaning		Speed of Verbal Association	Speed of Non- Verbal Association	Eye-Movement Record Data	Length of Eye- Movement of Record		
II.....	.205	.188	.214	.440	.337	.090	-.393	.157	.679	-.722	4	19
III.....	.397	.719	.647	.793	.673	.536	-.412	-.339	.673	-.795	9	22
IV.....	.427	.701	.628	.498	.364	.456	-.480	.157	.678	-.860	9	24
V.....	.195	.625	.286	.453	.238	.439	-.493	-.048	.549	-.982	6	35
VI.....	.534	.438	.067	.549	.615	.662	-.381	.027	.428	-.822	8	30
IX.....	.064	.272	.116	-.099 ^c	.092 ^c	.209	.052	-.131	.174	-.585	1	35
XIII.....	.437	.573	.337	.287 ^d	.120 ^d	.254	-.282	-.198	.467	-.804	7	30
No. of significant correlations.....	4	5	3	6	4	4	5	0	6	7	44	....

^aCorrelated with average frequency of forward fixations of the eyes.

^bFor minor fluctuations in N, see earlier tables in the chapter.

^cTraxler Silent Reading Test.

^dNew Stanford Reading Test.

TABLE 27

RELATION OF NINE VISUAL FACTORS TO THE SPAN OF RECOGNITION,
ARRANGED ACCORDING TO GRADES

Grade Level	Binoocular Acuity	Fusion (Near)	Vertical Im- balance (Near) ^a	Lateral Im- balance (Far) ^a	Sharpness of Image (Near)	Sharpness of Image (Far)	Stereopsis	Blind Spot	Visual Form Span	No. of Significant Correlations	N
II.....	-.032	-.422	-.184	-.426	-.218	-.239	-.057	.215	-.133	1	19
III.....	.184	-.036	.605	.671	.017	-.200	.050	-.057	-.126	0	22
IV.....	-.084	-.475	.481	.000	-.374	-.288	-.033	-.251	.207	2	24
V.....	-.128	.100	-.138	-.246	.106	.397	.322	-.283	.247	2	35
VI.....	.019	.166	-.183	-.122	.026	-.026	.062	-.269	-.219	0	30
IX.....	-.053	.016	.313	.186	.221	.110	-.147	-.193	.101	0	34 ^b
XIII.....	.086	-.171	-.077	-.040	.043	.070	.494	-.124	-.077	1	35
No. of significant correlations.....	0	2	0	0	1	1	2	0	0	6	....

aBi-serial r.

bOne subject with injured eye omitted.

Reference to the last column of Table 26 shows that the least number of significant correlation coefficients between psychological factors and the span of recognition occur at the second and ninth grades. In the case of the second grade, the failure to find significant coefficients for five of the factors, even when the majority of correlation coefficients at other levels were significant, may be in part due to the fact that it is much more difficult to accurately analyze the actual reading ability of the immature child at the second-grade level than at higher levels where his reading ability has crystallized into a fairly systematic attack upon the printed page. The writer is not at all sure, furthermore, that the routine of testing in this study was not somewhat too exacting for some of the students at this level. At the ninth-grade level, on the other hand, the competence of most of the readers was assured, it will be remembered, by the method of selection in which the superior half of the ninth grade was employed for testing in this study. There is little doubt in the writer's mind that this method of selection in itself operated to lower the correlation consistently at this level. The effect of such selection tended in many cases to restrict the range of the distribution of data or to bunch the scores around a central point, as the tables in Appendix III illustrate. As a result, the correlations may be lower, other things being equal, than when a greater spread of a particular factor is indicated. Another element which may have affected the degree of correlation at this level is the amount of co-operation of the subjects of the ninth grade. The writer was under the impression at the time of the testing that the best co-operation of his subjects occurred at other levels than the ninth grade. It seems entirely possible that this may have been due somewhat to the fact that since the Mooseheart students experience a rather heavy testing program throughout their life there, they may become more inured to tests and test situations as they progress from grade to grade and thus may tend to be less responsive in the ninth grade to testing such as that carried out in this study.

In Table 27, however, there appears to be little trend in the number of correlation coefficients at various grade levels, although it might be pointed out that nine-tenths of the significant coefficients are found at or below the fifth grade. This fact, however, is of minor importance by comparison with the

contrast mentioned previously between the small number of significant correlation coefficients for the visual factors measured and the large proportion of significant coefficients among the psychological factors investigated. It should also be pointed out that the subjects of this study may have had ocular attention that is superior to that provided the average public-school student, in that each Mooseheart student is carefully tested for ocular efficiency regularly by a staff physician as a part of the preventive program of medical service at this institution. Likewise, 51 per cent of the thirteenth-grade students had received ocular correction, and the group without exception reported recent ocular attention. The fact that attention to the visual efficiency of the subjects of this study may have been more adequately provided for than in an unselected group may of course have affected to some extent the degree of relationship between such visual factors and the span of recognition. Nevertheless, for this study at least, and for the techniques and materials adopted in this study, there is evidence here of much significant relationship on the one hand between certain psychological factors and the span of recognition, and on the other hand, correspondingly little evidence that the visual factors investigated are associated to any significant degree with the span of recognition.

Summary

This chapter was devoted to setting forth the results of correlation analysis between selected factors, both psychological and physiological, and the span of recognition. A considerable degree of positive and significant relationship was observed for those psychological factors, including intelligence, which were measured by laboratory and non-laboratory techniques, the outstanding exception being that of speed of non-verbal association. On the other hand, the visual factors measured by laboratory techniques yielded no consistent evidence of significant relationship to the span of recognition.

CHAPTER VI

THE SIGNIFICANCE OF THE FACTORS INVESTIGATED IN RELATION TO THE SPAN OF RECOGNITION

The twofold purpose of the present chapter is to comment more fully upon the significance of the findings of the previous chapter and to discuss additional aspects of the study which seem to merit attention. In order to achieve this purpose, consideration will be given to (1) the results of further analysis of the data, (2) the illustration of certain combinations of abilities which are characteristic of representative good and poor readers when judged by the criterion of maturity of the span of recognition, and (3) the relation of this study to the general field of visual perception.

Further Aspects of the Results of This Study

The tables in Appendix III illustrate the distribution of the data of the study and are designed to furnish such basic information as trends in the distribution of scores, central tendencies, and degree of dispersion of the data proper. A certain amount of interpretative comment seems justifiable, however, in a chapter devoted to the significance of the factors investigated, provided that such comment serves to clarify or in any way qualifies the interpretation of the relationship of these factors to the span of recognition as observed in the foregoing chapter. The discussion engaged upon in this section is intended to supplement the type of information to be derived from Appendix III.

Intelligence and reading ability.--Intellectually, on the basis of intelligence test scores, the median Mooseheart subject is at or above the average, the median student in Grades III, V, and in the selected ninth-grade group being relatively more advanced in this respect than the median student in other grades tested. Likewise, the median thirteenth-grade student is approximately the equal intellectually of the average student in his class, which as a group is of somewhat superior intelligence.

In various measures of reading ability, the Mooseheart students appear to be for the most part of at least average ability and in some cases definitely above average. Reading ability of this group, as well as that of the thirteenth grade, may be indicated by a comparison of median scores per grade with norms for the respective reading tests which were administered. Table 28 shows such a comparison of scores and norms for reading rate.

TABLE 28
COMPARISON OF READING RATE SCORES WITH GRADE NORMS

Test	Grade						
	II	III	IV	V	VI	IX	XIII
<u>Courtis</u> (WPM)							
Score (Md)....	72.5	155.0	140.0	192.1	154.0	....	....
Norm (Md).....	84	113	145	168	191	....	....
<u>Traxler</u> (WPM)							
Score (Md)....	....	....	....	....	....	384.4	....
Norm (Md).....	....	....	....	....	....	324	....
<u>Pressey</u> *							
Score (M).....	....	....	....	....	....	....	19.8
Norm (M).....	....	....	....	....	....	....	20

*Derived scores, the norm being the mean score of the class.

It will be noticed that in the second and fourth grades the scores are slightly below the norm, while in the sixth grade there is a decided lag. Other Mooseheart scores are definitely better than the norms. Similar data is given in Table 29 for comprehension upon the rate selection. In every grade except the sixth and thirteenth grades the scores exceed the norms, and in these two grades the differences are negligible. Comparisons of scores and norms for paragraph comprehension and word meaning are given in Tables 30 and 31, respectively. In every case except one, the median student is equal to or exceeds his expected norm. In the latter case, the median sixth-grade student is slightly below his

expected grade score, which, since these students were tested near the close of the academic year, should be approximately 7.0. Comparison of the performances of different grades upon these tables which illustrate certain phases of their reading ability will show that as a rule the scores made by the median student of the third grade tend to approach that of the median fourth-grade student, while disparity between the median scores for fifth- and sixth-grade students is even less. Such observations confirm in

TABLE 29
COMPARISON OF READING COMPREHENSION SCORES
WITH GRADE NORMS

Test	Grade						
	II	III	IV	V	VI	IX	XIII
<u>Courtis</u>							
Score (Md)....	71.0	86.0	96.0	93.3	93.3	....	....
Norm (Md).....	59	78	89	93	95	....	....
<u>Traxler</u>							
Score (Md)....	....	....	....	....	....	12	....
Norm (Md).....	....	....	....	....	....	11.9	....
<u>Pressey</u>							
Score (M).....	....	....	....	....	....	....	19.3
Norm (M)*.....	....	....	....	....	....	....	20

*Norm = class mean.

general the superior ability of the third and fifth grades which was noted above for intelligence. Since, as already has been pointed out, the ninth and thirteenth grades are likewise equal to or above the average in intelligence and reading ability, it may be seen that the subjects employed in this study represent on the whole but a slightly above average sample of the school population in these respects.

Span of perception.--The performance of students upon the span of perception test may be somewhat clarified by examination

TABLE 30

COMPARISON OF PARAGRAPH COMPREHENSION SCORES
WITH GRADE NORMS

Test	Grade						
	II	III	IV	V	VI	IX	XIII
<u>New Stanford</u>							
Score (Md) ^a ...	3.3	4.9	5.2	7.0	7.0	....	....
Norm ^a	2.6	3.6	4.6	5.6	6.6	....	....
<u>Traxler</u>							
Score (Md)....	....	....	....	....	....	28.0	....
Norm (Md)....	....	....	....	....	....	24.3	....
<u>Pressey</u>							
Score (M).....	....	....	....	....	....	....	20.2
Norm (M) ^b.....	....	....	....	....	....	....	20.0

^aEquivalent grade scores.

^bNorm = class mean.

TABLE 31

COMPARISON OF WORD-MEANING SCORES WITH GRADE SCORES

Test	Grade						
	II	III	IV	V	VI	IX	XIII
<u>New Stanford</u>							
Score (Md) ^a ...	3.7	4.8	5.1	6.4	6.7	....	....
Norm ^a	2.6	3.6	4.6	5.6	6.6	....	....
<u>Traxler</u>							
Score (Md)....	....	....	....	....	....	26.0	....
Norm (Md)....	....	....	....	....	....	19.3	....
<u>Pressey</u>							
Score (M).....	....	....	....	....	....	....	20.4
Norm (M) ^b.....	....	....	....	....	....	....	20.0

^aEquivalent grade scores.

^bNorm = class mean.

of the modal scores for each grade as shown in Table 32. The modal score is instructive in these cases inasmuch as there was a tendency for scores to pile up rather definitely at one point in every case except the fifth grade. This fact is illustrated both by reference to Table 48 for the distribution of scores in Appendix III and also to the last column of Table 32. In other than the fifth grade, it will be noted from the latter table, from at least one-fourth to slightly more than one-third of the total number of best scores were made upon these items indicated.

TABLE 32

MODAL SCORES UPON THE SPAN OF PERCEPTION TEST, SHOWING THE
NUMBER OF STUDENTS PER GRADE WHO READ THE ITEM
CORRECTLY AND THE PERCENTAGE WHICH THIS
NUMBER IS OF THE TOTAL NUMBER OF
STUDENTS PER GRADE

Grade	Phrase	No. of Letter Spaces	No. of Students	% of Total Number of Students
II.....	jump up	7	6	32
III.....	jump up	7	6	27
IV.....	small pig	9	8	33
V.....	we want to play	15	7	20
VI.....	small pig	9	9	30
IX.....	we want to play	15	12	34
XIII.....	we want to play	15	13	37

Since the span of perception test was scored by counting the widest span read correctly before two consecutive errors were made, a brief analysis of the errors upon those items which immediately follow the widest span correctly read by the modal student per grade is given. At the second- and third-grade levels, for example, the modal student failed to read correctly the phrases "good boy" and "small pig," the phrases which immediately followed "jump up." "Good boy," for example, was almost invariably read "good bye" by those who misread it. This is an excellent example of how a familiar word form may arouse a meaning which is likewise familiar, yet neither of which is verified by sufficiently accurate

perception. The phrase "small pig" was most frequently misread as the antonyms "small -- big." Those students, on the other hand, who read as many as nine letter spaces correctly as indicated by the modal scores for the fourth and ninth grades, were inaccurate in their perception of the phrases "it is blue" and "he says yes." The last word of the former phrase was frequently missed entirely, while the latter phrase was usually interpreted "he (or 'she') says so (or 'no')." At the fifth-, ninth-, and thirteenth-grade levels approximately one-third of the students failed to read the phrases "her cat ran away" and "then go back home." The first of these phrases was read in a variety of ways, a very common one being "he can run ('away')." The second of these phrases was variously read as "go back home," "they go home," and "go back." It should also be noted that at the fifth-grade level, an additional 17 per cent could read only nine letter spaces correctly.

In most cases there was a definite tendency on the part of the subjects to rely upon context or upon very slight cues for the reading of a phrase just so soon as the phrases became too long for the student to grasp easily. Thus as is probably true of most measures made by means of the tachistoscope, there is some element of guessing at levels of increased difficulty. The distribution of scores as indicated by Table 48 of Appendix III implies, furthermore, that the degree of difficulty from item to item may not be entirely uniform. It follows that this measure of the span of perception is clearly not absolute and entirely satisfactory. Further experimentation is needed before a graded scale of difficulty can be accurately established.

Speed of association.--Speed of association in this study was measured, it will be recalled, for both verbal and non-verbal materials in roughly comparable situations. Correlation coefficients between these factors and the span of recognition were in no case significant for the non-verbal materials, but in five grades were significant for the verbal materials. Comparison of the median speed of association scores for these two types of materials is made in Table 33. There is a definite trend toward faster speed of association of both verbal and non verbal materials from the lower to the upper grades. In the case of the verbal materials, at the thirteenth grade the average speed of association for the median student is roughly three times as fast as that for the median second-grade student. On the other hand,

the median thirteenth-grade student associates non-verbal materials of the kind measured in this study only twice as fast, on the average, as the median second-grade student. Other differences in speed of association for the two types of materials are brought out by attention to the bottom row of the table marked "Difference." At the second-grade level, there is a wide difference in the time taken to read verbal and non-verbal materials on the average by the median student, yet at the thirteenth and even at the ninth grade, this difference is negligible. Furthermore, from the second to the fourth grade, the difference in speed of association is more than halved.

TABLE 33
DIFFERENCES IN AVERAGE SPEED OF ASSOCIATION* PER GRADE
BETWEEN VERBAL AND NON-VERBAL MATERIALS

Kind of Material	Grade Level						
	II	III	IV	V	VI	IX	XIII
Verbal.....	31.6	25.0	21.4	17.2	17.5	12.5	10.2
Non-verbal.....	19.0	16.0	16.5	13.9	13.5	11.1	9.5
Difference..	12.6	9.0	4.9	3.2	4.0	1.4	0.7

*Measured in one-tenth of a second.

Table 33 as a whole suggests, indeed, a definite trend toward more rapid speed of association at successively higher grade levels. This trend is interrupted, it will be noted, only by slight retardation on the part of the sixth grade for verbal materials and the fourth grade for non-verbal materials. However, both of these grades have already been shown to be of somewhat lesser ability in intelligence and reading than their companion grades. For materials of the kind employed in this study, the median student at the second-grade level completes a simple idea that is verbally expressed rather slowly, but takes only about two-thirds as much time to complete an idea represented by two pictorial objects. By the time the fourth grade is reached, however, the median student has improved in his ability to complete a verbal idea so much more than is the case for non-verbal

materials, that the difference in speed for these two kinds of stimuli has been appreciably reduced. Furthermore, at the ninth and thirteenth grades, which, it must be remembered, are relatively superior groups, the average speed of association of the median student tested is practically as fast for verbal materials as for non-verbal ones. In general, then, it may be said that at successive grade levels the median student tends to quicken his speed for associating two ideas in the act of completing a thought that is represented either by verbal or pictorial symbols, but that the latter type of symbols are typically read the faster.

The Telebinocular examination.--For the most part, scores upon the various items of the Telebinocular examination tended to lump themselves negatively in the case of the median student at the various grade levels tested. For example, the median student at all grade levels showed at least 100 per cent binocular acuity and fusional ability as measured by these tests. Furthermore, 69 per cent of all students tested had at least 100 per cent binocular acuity, and 74 per cent equally high fusional ability. As for imbalance of the eyes, 87 per cent showed no lateral imbalance beyond the normal range, while 88 per cent displayed no significant vertical imbalance of the eyes.

Sharpness of image was measured, it will be recalled, in six meridians for each eye, at both the near and the far point of vision. The median student showed no defects in sharpness of image at the near point in five grades, but on the other hand for five grades at the far point the median student showed on the average one defect in sharpness of image in one meridian. The difference in relative freedom from defects in sharpness of image may be expressed in other terms by noting that 65 per cent of all students tested had no defects at the near point, whereas but 45 per cent of the same group were free from all defects at the far point. This difference of 20 per cent in the ability of a group to see less sharply in at least one meridian of the eyes at the far point than at the near point appears to be significantly large. The relationship of such a finding to the act of reading at the near point, however, seems to be correspondingly doubtful.

With regard to stereopsis ability, the results of this study indicate that when the students were measured by the DB series card for stereopsis, 67 per cent of all students showed 100 per cent stereopsis, which, it will be remembered, is actually

supposed to be about 55 per cent perfect stereopsis. According to the test results for this series, furthermore, the median student at each grade level made the satisfactory score of 100 per cent stereopsis. However, upon the DC series of cards which purports to measure the degree of stereopsis more accurately, the median student showed but 50 per cent stereopsis at three grade levels, and but 60 per cent stereopsis at the remaining four grade levels. The percentage of students displaying perfect stereopsis upon this more refined scale was but 26 per cent.

As a group, the subjects appear to be adequately cared for with regard to the correction of eye defects measured in this study. They also seem to enjoy good vision, as far as the absolute condition of their eyes is revealed by the comments in this section and in Tables 52-58 in Appendix III. The comparatively insignificant role which the aspects of vision measured by the Telebinocular test evidently plays in the actual act of reading has been stressed both in the preceding chapter and in the first section of this chapter. That this type of evidence may not be absolutely conclusive, however, is suggested by recent criticisms of certain aspects of the Telebinocular tests by eye specialists whose tendency to look with suspicion upon the Telebinocular tests as accurate and efficient screening devices for visual defects should at least be kept in mind.¹

The visual form span.--In the chapter on methods and techniques it was explained that the measure of visual form employed in this test was the combined range of vision for the left and right eye on the horizontal axis as measured by a subject's ability to clearly perceive the corners of a standard five-millimeter square white target. In Figure 3, a graphic representation is shown of the mean size of the visual form span per grade. It will be noted that there is a tendency for the size of the field to increase as the grade level advances, with the notable exception of Grade XIII in which there is an approximation of the mean visual span for the fourth grade.

¹See H. Molish and E. Reese, "A Comparison of the Betts Tests of Visual Sensation and Perception with a Standard Clinical Examination," American Journal of Optometry, XVI (March, 1939), 110-17. L. Oak, "An Appraisal of the Betts Visual Sensation and Perception Tests as a Sorting Device for Use in Schools," Journal of Educational Psychology, XXX (April, 1939), 241-50.

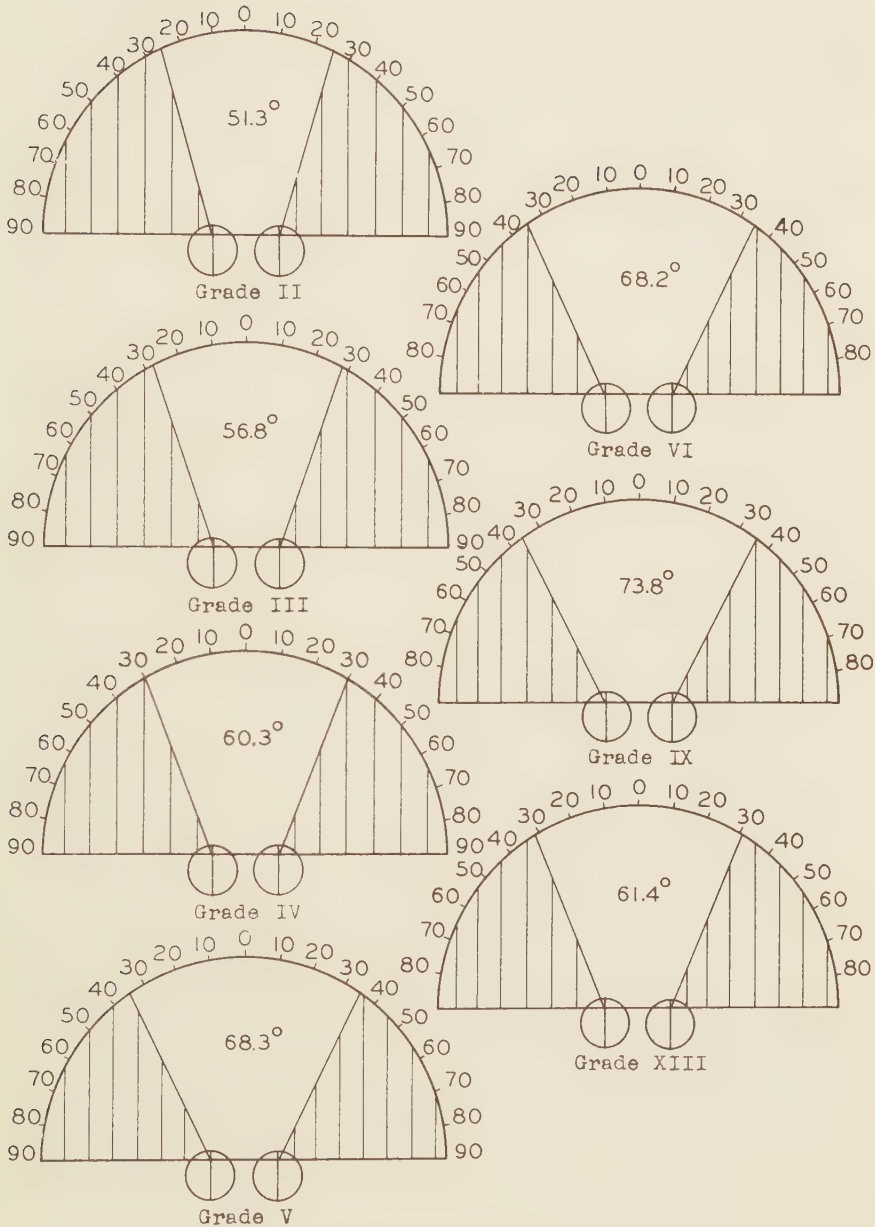


Fig. 3.--Mean size of the visual form span per grade

It was shown in the preceding chapter that the size of the visual form span bears no significant relationship to the span of recognition. Perhaps the most obvious reason why there should be no demonstrable relationship is the great discrepancy on the average between the portion of the retina actually employed in a process as keenly discriminative as reading and that portion of the retina used by the median student in determining the size of the visual form span for the purposes of this study. The relative size of these areas should not be misunderstood. For example, Figure 3 shows that the median student saw clearly the corners of the target at a distance of from approximately twenty-five to thirty-seven degrees to either side of the point of regard, depending upon the grade level. Furthermore, one-half of the students at each grade level claimed to see the target clearly with peripheral vision considerably farther away from the point of regard than the grade medians shown in this figure would indicate. On the other hand, as Dearborn has shown in a concise statement of the amount of retinal area involved in reading, the foveal and macular areas are those principally involved in the act of reading:

Measurements show that at a reading distance of fourteen inches, a word of only four or five letters in eight- to ten-point type covers the area of the greatest acuity of vision. . . . Raymond Dodge has shown that at an angle of fifteen degrees to the side of the point of regard, the shadowy forms of words may still be seen sufficiently to influence the resulting perception, and that the general configuration of the word may be sensed when the word itself cannot be recognized. At the usual reading distance of fourteen inches the average fovea subtends an angle of seventy minutes and the average macula one of about twelve degrees. If one made use of only one-half of the area of the macula, there would be the chance for the mind to perceive forty to fifty letters of eight- to ten-point type Our hypothetical use of one-half of this inner area of the macula would employ but three degrees to either side of the point of regard. In view of Dodge's observations at an angle of fifteen degrees to the side of the point of regard, it seems safe to conclude that we can see clearly enough more letters, words, and phrases than we ordinarily perceive.¹

It seems clear, then, that the visual form span as measured in this study tends to be on the average considerably larger than the area actually utilized in the perception of words in reading.

The same type of measurement used in determining the visual form span for the horizontal axis of the eyes was also

¹W. F. Dearborn, "Motivation versus 'Control' in Remedial Reading," Education, LIX (September, 1938), 5-6.

used, it will be recalled, in measuring the extent of visual discrimination of this type in the eight principal meridians of each eye. The mean point of visual discrimination of form is shown for all grades in Figures 4 and 5. These figures show that on the average there is an area of clear vision of over twenty degrees from the point of regard in each meridian of each eye. In view of Dearborn's remarks which were just quoted, there is evidently ample vision available in all directions that is at the same time more than adequate for the purpose of fairly discriminative seeing.

The blind spot.--Measurement of the blind spot for the purpose of determining the amount of enlargement brought up the question of the definition of an enlarged blind spot. It seems fairly apparent that Brombach¹ thinks of enlargement of the blind spot in terms of many degrees of enlargement. This is at least true of the cases presented for analysis in his article. Text-books on ophthalmology usually do not specify the amount of enlargement considered abnormal, according to a survey of texts made by the writer, although the following statement is found in one text: "Should the horizontal diameter of the blind spot for motion exceed 6° , according to Van der Hoeve, it is larger than normal, and may indicate the presence of beginning pathologic change."² In accordance with the implication of the quoted passage that even small enlargements of the blind spot may be of significance, the writer arbitrarily adopted the policy of considering a blind spot enlarged when either its horizontal or vertical axis exceeded normal size by one or more degrees.

Forty-eight per cent of the subjects measured had no enlargement of the blind spot, while 52 per cent had blind spots which ranged from one to twenty-one degrees. However, 75 per cent of the latter group showed enlarged blind spots of 2.9° or less, while of the remaining 25 per cent of this group, but one-sixth had blind spots which exceeded eight degrees. Thus it may be seen that appreciable enlargement of the blind spot was restricted to a relatively small group of the subjects. Some

¹Op. cit.

²George E. De Schweinitz, Diseases of the Eye, p. 92. 10th ed., Philadelphia: W. B. Sanders Co., 1924.

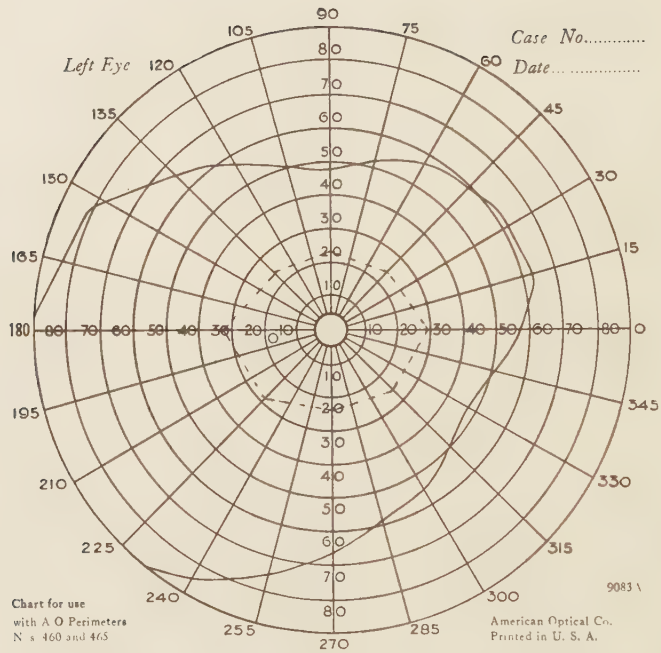


Fig. 4.--Mean size of the field for the discrimination of visual form in eight meridians of the left eyes of 200 students.

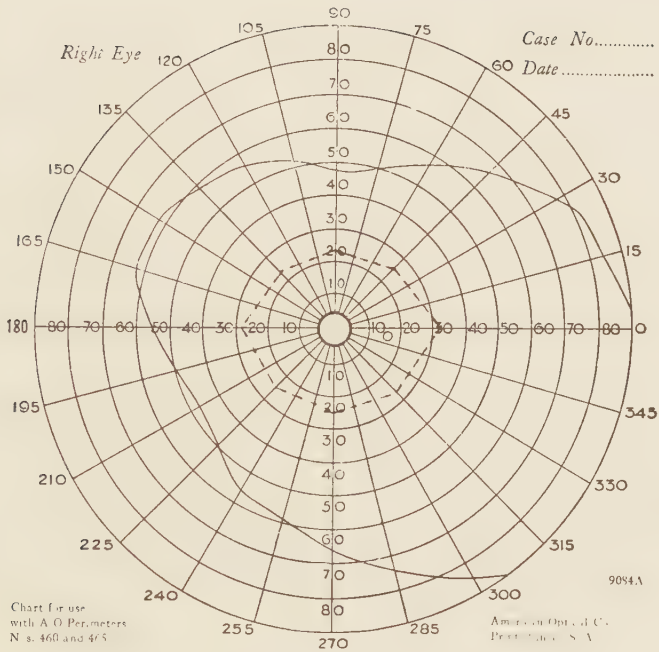


Fig. 5.--Mean size of the field for the discrimination of visual form in eight meridians of the right eyes of 200 students.

tendency for enlargement of the blind spot to be more prevalent in the lower than in the upper grades of the study is shown by the fact that the median student in Grades II through IV had more than a two-degree enlargement of the blind spot, and that the median student in Grade V had slightly over a one-degree enlargement. In Grades VI, IX, and XIII, however, the median student showed no enlargement of the blind spot whatsoever.

Résumé.--The foregoing discussion of the various factors considered in relation to the span of recognition has been presented in order to throw some light on certain aspects of the results of this study which may influence one's interpretation of the significance of the factors themselves or of the relationships discussed in the previous chapter. Information such as that pertaining to the nature of the intelligence, reading ability, and the performance of the subjects upon some of the experimental laboratory phases of the study in particular should be kept in mind as qualifying elements with regard to the degree of relationship involved. It seems reasonable, for example, that with students of lower average intelligence and reading ability, certain results of the study would assume greater or less significance. On the other hand, had all students been superior in most academic respects, certain differences in the results would probably again have followed. One fact which should be kept constantly in mind in the interpretation of the significance of this study and the factors involved is that with the exception of the ninth grade, and possibly the thirteenth grade, each grade level is fairly representative of the distribution of abilities of a normal school population.

Individual Variations in Combinations of Factors Studied

Seven cases will be briefly discussed in this section with the intention of illustrating variations in the combinations of psychological and visual factors that may be associated with either a superior or inferior span of recognition. For this purpose two outstanding cases at the third- and fourth-grade levels will be compared respectively with the case in each of these grades which shows the smallest span of recognition. Variation at the thirteenth-grade level will be illustrated by a comparison of the two most proficient readers as far as span of recognition

is concerned, and these two in turn will be compared with a university student having one of the narrowest spans of recognition. Since the factors studied were measured and scored necessarily in such a variety of ways, comparisons will be limited for the most part to indicating in which quarter of his respective grade--low, third, second, or high--the student was placed.

Third-grade level.--Case 23 is that of a girl, aged eight years and eleven months, with a mental age of 9-8. Her average span of recognition is 2.0 cm. For the ten psychological factors investigated, this girl is in the highest quarter of her grade, except in intelligence, in which case she ranks in the second quarter. Of the visual factors included in the study, this girl ranks in the upper quarter of her grade with respect to binocular acuity and fusional ability, and showed neither lateral nor vertical imbalance. In sharpness of image at the near point and in the size of her visual form span she ranks in the second quarter, while in sharpness of image at the far point and in percentage of stereopsis she drops to the third quarter. The blind spot is enlarged in both eyes to a slight extent.

By comparison, Case 26, a boy in the third grade, nine years old, with a mental age of 8-10, has an average span of recognition of .5 cm. He ranks consistently in the low quarter of his grade in all but three of the ten psychological factors studied. In these three factors--average number of regressions per line, intelligence, and speed of non-verbal association--he ranks in the third quarter. As in Case 23, this boy has high binocular acuity and fusional ability, and no vertical imbalance, so that he ranks in the upper quarter of his grade with respect to these factors. However, he shows some degree of lateral imbalance and drops to the lowest quarter with respect to the percentage of stereopsis and size of the visual form span he displayed. Contrary to Case 23, on the other hand, this boy has perfect sharpness of image at both the near and the far point. Again, however, he too shows some enlargement of the blind spot.

If the performance of these two cases is considered conjointly, it will be seen that as far as the psychological factors are concerned, Case 23 is definitely superior to Case 26 in that at no point did the former drop below the second quarter of her grade, while contrariwise at no point did the latter boy rise above the third quarter of his group. The consistent superiority

of Case 23 is by no means upheld, however, in the case of the visual factors involved, for in respect to two visual abilities Case 26 is the superior, and in two other abilities is the equal of Case 23.

Fourth-grade level.--A similar type of distinction between the amount of variation to be found with regard to psychological factors on the one hand, and visual factors on the other, is to be found by comparing the performance of Cases 64 and 58 at the fourth-grade level. Case 64, a boy aged nine years and ten months, has a mental age of 12-5 and an average span of recognition of 1.7 cm. In six of the psychological factors studied, he is in the upper quarter of his class, but drops to the second quarter in paragraph comprehension, word meaning, and speed of verbal association, and to the third quarter in speed of non-verbal association. He has excellent binocular acuity, no vertical or lateral imbalance of the eyes, and no defects in sharpness of image at either the near or far points. On the other hand, he ranks in the lower quarter of his class with respect to his fusional ability, and in the third quarter in stereopsis and size of the visual form span. The blind spot is slightly enlarged in both eyes.

Case 58 is that of a girl, aged nine years and six months, with a mental age of 9.0 and an average span of recognition of .6 cm. This girl at no point rises above the third quarter of her grade in the psychological factors studied, and at only one point does her performance equal that of Case 64, and that is in speed of non-verbal association, a factor which, it will be remembered, was found to have no significant relationship to the span of recognition. She shows perfect binocular acuity and perfect fusional ability, far exceeding the performance of Case 64 in the latter ability. In other visual measures, however, she is uniformly inferior to the latter case. She shows both lateral and vertical imbalance of the eyes and ranks in the third quarter with regard to sharpness of image at the near and far point and in the size of the visual form span. In percentage of stereopsis she ranks in the lower quarter. The blind spot in her left eye is likewise considerably enlarged in its horizontal meridian. In general, it may be said for these two cases at the fourth-grade level that the line is less sharply but hardly less conclusively drawn between their performances upon psychological factors than

was true for the two preceding cases, but that on the whole, Case 58 shows more serious visual defects than did Case 64.

Thirteenth-grade level.--Cases 167 and 184 show the broadest spans of recognition at the university freshman level, yet such variations in other factors that it seems worth while to consider at this point the different patterns which these variations form.

Case 167 is that of a girl, aged seventeen years and five months, who ranks in the upper quarter of her group with regard to intelligence and also made the broadest average span of recognition of all subjects used in this study--2.3 cm. This girl is uniformly superior in the psychological factors measured, dropping to the second quarter of her grade only in paragraph comprehension and span of perception. With regard to visual factors, on the other hand, she shows perfect binocular acuity, no vertical imbalance, no defects in sharpness of image at either the near or the far point, and has no enlargement of the blind spot. She has some lateral imbalance of the eyes, and is in the second quarter of her grade in size of the visual form span, in the third quarter in fusional ability, and in the lowest quarter in percentage of stereopsis.

Case 184 is likewise that of a girl, aged eighteen years and nine months, who ranks in the lower quarter of the class according to her score upon the American Council Psychological Examination. Her average span of recognition is 2.0 cm. While she is in the upper quarter in the average number of regressions made per line, she drops to the second quarter in the length of the eye-movement record, and then to the third quarter for all other psychological factors except word meaning (and intelligence), in which abilities she is in the lowest quarter of the class. With regard to psychological factors, she has perfect binocular acuity, no vertical imbalance of the eyes, no defects in sharpness of image at the near point, and no enlargement of the blind spot. Like Case 167, she has lateral imbalance of the eyes, however, ranks in the second quarter of her class with regard to the size of the visual form span, and in the lowest quarter in percentage of stereopsis. Contrary to Case 167, Case 187 is also in the lowest quarter in defects in sharpness of image at the far point and in fusional ability. Thus it may be seen by a comparison of two cases with superior ability in the mechanics of reading,

i.e., span of recognition, that this ability is not necessarily related to high ability in other psychological and visual factors such as those investigated in this study.

A final case study may be of value at this level to show likewise a pattern of abilities for a student with an average span of recognition of 1.2 cm., which places him in the lowest quarter of his university class. This student, Case 189, is a boy aged seventeen years, three months, with an intelligence score which places him in the second quarter of his class. He also ranks in the second quarter in word meaning, but drops to the third quarter in reading rate, comprehension, span of perception, and speed of association for both verbal and non-verbal materials. He is in the lowest quarter in average number of regressions per line, length of the eye-movement record, and in paragraph comprehension. However, with but three exceptions, his visual abilities place him in the upper quarter of his grade. He shows both lateral and vertical imbalance of the eyes, and has a visual form span sufficiently restricted to place him in the lower quarter of his class.

Résumé.--The three latter cases at the thirteenth-grade level are illustrative of patterns of psychological and visual abilities which may on the one hand be consistently high for the most part or may show great variations from high to low achievement depending upon the nature of the ability tested. Case 184 represents a pattern which is probably typical of many other cases in this study. On the other hand, it seems equally true that the disparity in the level of achievement in psychological factors which has been observed at lower levels when a student with a broad span of recognition is compared to a student with a very narrow one, is likewise typical of this study. This is indeed borne out by cases 167 and 189 at the university freshman level, for in no one psychological ability do these students meet. For the visual factors measured, however, there seems to be little consistency in the degree of visual efficiency displayed by either the student with the superior span of recognition or the student with a definitely inferior one. The student with the broad span of recognition may have imbalance of the eyes, may have defects in the ability to see an image sharply, may have an enlarged blind spot. This may be equally true of the student with the very narrow span. Thus it appears that in general the sample case studies

selected for presentation here tend to bear out the degrees of relationship observed in the preceding chapter; namely, that psychological factors tend to be associated more significantly and to a higher degree with the span of recognition than do visual factors.

The Relation of This Study to the General
Field of Visual Perception

It has been pointed out previously that the present study of the span of recognition deals with merely one aspect of the process of visual perception. Earlier in the study, furthermore, the significant differences between the span of recognition and the span of perception were noted. It is proposed in the present section to consider further this study in relation to the broader field of visual perception. To this end, the act of visual perception will be discussed briefly, while word perception will be entered into in more detail. Consideration will then be given to the specific ways in which the results of the current study may be related to the field of visual perception.

Nature of an act of visual perception.---Carr¹ has pointed out the three essential aspects of an act of perception of any sort: (1) a stimulating situation, (2) an attentive adjustment to this situation, and (3) the arousal of its meaning or significance. There is, according to Vernon, apparently general agreement upon a number of steps involved in an act of perception. Vernon² describes six stages:

1. Perception of gradually increasing specificity as the salient parts rise clearly out of the background.
2. Kinaesthetic and organic sensation, either general or localized, or both.
3. Imagery, predominately visual, but sometimes also kinaesthetic or auditory-kinaesthetic.
4. Associated imageless thought.
5. Feeling of familiarity, ease of apprehension, affective tone.
6. Attribution of meaning and complete assimilation.

¹Harvey A. Carr, Psychology: A Study of Mental Activity, p. 110. New York: Longmans, Green and Co., 1926.

²Op. cit., p. 103.

Vernon also points out that telescoping of these stages may occur, in that the last one may precede any other stage except stage 1.

Identification of the above stages is based upon introspection. Such identification is assisted by the tachistoscope, by means of which much information has been gained about the perceptual process. The tachistoscope literally arrests the development of perception at different stages and has thus been particularly valuable in ascertaining the nature of word perception.

Nature of word perception.--Word perception is merely a particular kind of perception. Carr, at a later point in his book, amplifies his remarks upon the nature of perception by stating that the arousal of meaning is dependent upon the "indirect and partial arousal of some of the previous experiences associated with it [the perceptual object]." ¹ The perceptual aspect of reading, according to this view, may be considered as a "process of establishing associations, or as a process of endowing symbols with meaning." ² The symbols used in reading are words. Thus an understanding of the nature of word perception, of how we perceive words, is essential to an understanding of the reading process.

There is a long history of experimentation primarily with tachistoscopic techniques to determine what are the essential clues to word recognition. While variations in the stimulus words, length of exposure, and other factors used make comparison of the results of different investigators difficult, nevertheless in the identification of the isolated word, two main points of view are distinguishable: (1) advocacy of word form as the essential distinguishing feature of the word, and (2) advocacy of the primary importance of letters or groups of letters, variously termed "determining," "dominant," or "significant" letters or letter complexes.

Briefly, it may be said that the proponents of word form as the dominating aspect of word perception have demonstrated beyond doubt that this is a most important factor in the recognition of words. Cattell, ³ for example, early refuted the then prevalent impression that we perceive every letter in a word when we read. He showed that an average reader could perceive, in an exposure

¹Op. cit., p. 117.

²Ibid.

³J. M. Cattell, "The Inertia of the Eye and Brain," Brain, VIII (October, 1885), 295-312.

one one-hundredths of a second long in a tachistoscope, from three to four single letters, two unrelated words containing as many as twelve letters, or a sentence of four words. Cattell also found that words were recognized more quickly than single letters.¹ He concluded from this that word form must be the determining factor in word perception. This view was likewise supported by Erdmann and Dodge² who discovered that words could be recognized at distances at which individual letters could not be made out.

Other investigators such as Goldscheider and Müller,³ and others notably of the German school, lay great stress on the importance of characteristic letters or letter groups in word recognition. The clues for initial word recognition which are most frequently mentioned are ascenders, that is, letters which have parts projecting above the main body of the line of type, initial letters, and descenders. Ascenders are apparently more important as cues to word recognition than are descenders, as the early experiments of Huey⁴ showed when he had his subjects read lines the upper or lower parts of which were mutilated. The experiments of Tinker and Goodenough,⁵ who found that the initial letter is an important cue to word recognition in the mirror-learning of adults, and others in a more normal reading situation tend to support the conclusion that in normal reading progress from left to right across the page, initial letters may be in a favored position in word recognition.

It is important to note, however, that the investigators who stressed the role of dominant letters or letter groups usually considered these elements either as a means or as a cue to the perception of the word form, which is described as the "characteristic form" of the word, or as a means for clarifying and

¹J. M. Cattell, "The Time It Takes To See and Name Objects," Mind, XI (January, 1886), 63-65.

²B. Erdmann and R. Dodge, Psychologische Untersuchungen über das Lesen auf experimentelle Grundlage. Halle, Germany, 1898.

³A. Goldscheider and R. F. Müller, "Zur Physiologie und Pathologie des Lesens," Zeitschrift für Klinische Medizin, XXIII (1893), 131-67.

⁴E. B. Huey, The Psychology and Pedagogy of Reading, pp. 98-99. New York: The Macmillan Co., 1908.

⁵M. A. Tinker and F. L. Goodenough, "Mirror Reading as a Method of Analyzing Factors Involved in Word Perception," Journal of Educational Psychology, XXII (October, 1931), 493-502.

giving meaning to a word form first perceived as a vague optical entity. Indeed, certain ones recognized that some words in some circumstances are perceived merely by their word form. For example, Goldscheider and Müller¹ pointed out that familiar words are recognized as word forms and that as the words increase in difficulty, dominant letters or letter groups assume a role of paramount importance. This observation is supported in general by studies of word perception in children which show the importance of discrimination of detail in the unfamiliar word.

Still a third point of view may be advanced as a factor in the explanation of how words are perceived if the perception of more than the single isolated word is considered. This point of view stresses the influence of the larger context. Huey, in a summary of evidence concerning the nature of the perceptual process in reading, makes an admirable statement of this point of view by showing that a larger unit of recognition than the word, namely the phrase, is also of much significance in word perception. Following a discussion of word recognition by means of letters and word form, he adds:

The visual recognition of a familiar phrase, as a phrase, is but a repetition of the process described above, the recognition of constituent words as well as of letters in this case being partially inhibited in favor of the total recognition of the larger unit. Total visual form seems to be a less important factor in mediating the recognitions as a unit grows larger. Unitary recognition of phrases is very common in reading, for mentally the words do not stand entirely apart There is naturally a gradual progress, with practice, toward recognition in larger units, for those who learn first the recognition of letters and words

We must remember, however, that there are continual reversions to older habits, consciousness descending to even the level of letter-recognitions, on occasion, and very often taking account of particular words. Here there seem to be very great individual differences, and these depend partly, although never wholly, on the methods by which the reader has learned to read. We are brought back to the conclusion of Goldscheider and Müller that we read by phrases, words, or letters as we may serve our purpose best.²

Thus it may be said that the larger context, total word form, and those characteristic elements which differentiate one form from others may all be of significance in word perception, depending upon such factors as familiarity with the words involved, the purpose for which the words are read, or established habits of

¹Op. cit.

²Op. cit., pp. 114-16.

reading. Vernon's analysis of the perceptual processes of a mature reader in the reading of easy prose suggests that a fusion of these processes takes place in fluent word perception:

Some general form or contour is perceived, with certain dominating letters or parts arising out of it, as the "figure" rises out of the "ground." The ascending letters seem to play an important part, and an alternation of vertical and curved letters may also help in structuralizing the form. It is improbable that any individual letters or parts of words are recognized as such. But they are the details, standing out from the rest of the field, which differentiate its flat clearness, and finally produce perception of the "specific object." The words are not necessarily recognized or named individually, but the structuralized visual percept of the whole phrase or sentence arouses the more or less subliminal auditory or kinesthetic imagery of the sounds appropriate to that percept, or in some cases an incipient vocalization of these sounds. This total percept is then interpreted directly in accordance with the general meaning of the reading content.¹

It is this type of fluent, meaningful perception in continuous reading which should constitute one of the goals in the teaching of reading.

Specific relationships of this study to the field of visual perception.--The preceding discussion of that type of perception involved in reading, namely word perception, serves to clarify certain aspects of the results of the current study. It appears clear, for example, that those with extremely narrow spans of recognition are those whose attention is riveted upon the details of words, the recognition of which is difficult and laborious, not rapid and fluent. On the other hand, those with broad spans appear to approach the type of desirable fluent perception in which primary emphasis is given to the understanding of the larger context. That truly broad spans are typically not achieved early in the students' careers even in the reading of extremely easy materials was pointed out in chapter iv. At the same time it was noted that some individuals can and do achieve appropriately wide spans of recognition in the reading of such materials as early as the middle grades. Thus the possibility of achieving the goal of rapid and fluent reading of easy materials seems to be to some degree attainable early in the school life of the child.

The significance of a second aspect of the results of this study also attains new importance in the light of the foregoing analysis of the nature of word perception. It is granted that

¹Op. cit., pp. 118-19.

since word perception by its very nature is a phase of visual perception, a certain degree of purely visual ability is necessary for the ready and accurate perception of printed symbols. The bulk of the evidence presented in this study, however, emphasizes the fact that the purely visual recognition of the symbols is not nearly so important as the psychological factors involved in the endowment of those symbols with meaning. This evidence is in accordance with the analysis of the perceptual process made by Carr and in more detail by Vernon. Both writers stress the importance, not to say the necessity, of the attribution of meaning to a symbol in order to complete the process of perception. It would appear, then, that it will be by emphasis upon the meaningful aspects of the process of reading and upon the specific ways in which meaning may be fluently derived that future training in the development of a broad span of recognition may most profitably be pursued. In this sense it may be maintained that an early assumption of this study has been confirmed by the results of the study: namely, that fluent recognition habits leading to a broad span of recognition must be cultivated in reading. In this way the reader may be free to deal with the fundamental aspect of reading--the comprehension of what is read.

CHAPTER VII

CONCLUSIONS AND IMPLICATIONS OF THE STUDY

Summarizing Statement

The central problem of this study was to investigate the relation of a group of selected factors to the span of recognition. The ten psychological factors and nine visual factors chosen for study were described in detail in chapter iii. The relationship of these factors to the span of recognition was investigated at seven grade levels, including the second through the sixth grades, the ninth grade, and the thirteenth grade. The major techniques utilized in the administration of the study were those of the laboratory type and the standardized test. Correlation analysis and case-study techniques were chiefly relied upon in the interpretation of the data secured in the study.

An important initial objective of the study was to clearly differentiate the span of recognition from the span of perception in order to avoid misunderstanding in the proper and distinct use of these terms. These distinctions were dealt with in chapter ii. Later, in chapter iv, the development of the span of recognition was discussed. Finally, after the relationships of the selected psychological and visual factors to the span of recognition were discussed in detail, an evaluation was made of the relation of this study to the general field of visual perception.

Conclusions

The major conclusion of the study, stated broadly, is that the psychological factors selected for investigation in relation to the span of recognition were much more highly correlated with this basic factor than were the visual factors.

More specifically it may be said that for each of the following factors, significant correlation coefficients with the average span of recognition were found for the majority of the seven grades investigated: intelligence, reading rate, paragraph comprehension, word meaning, span of perception, average number

of regressions per line, rate of reading as measured by the length of the eye-movement record, and speed of verbal association. Reading comprehension measured through the use of the rate-of-reading selection, however, showed significant correlation coefficients at only three grade levels, although for every grade the coefficients were positive. The consistency of positive or negative correlation coefficients, as the case might be, for each of these factors was indeed high. Speed of non-verbal association, on the other hand, showed no significant degree of relationship to the span of recognition at any grade level and no consistency in the extent to which the relationship was positive or negative. Of the seventy correlations made between psychological factors and the span of recognition at seven grade levels, forty-four, or 63 per cent, were significant.

On the other hand, only six significant correlation coefficients were obtained for the sixty-three correlations made for the nine visual factors involved, representing but 10 per cent of the total number of correlations between these factors and the span of recognition. No consistency whatsoever was displayed with regard to uniformly positive or negative relationships, except in the case of the blind spot which was negatively correlated with the span of recognition at six out of the seven grade levels tested. Thus the factors of binocular acuity, fusion at the near point, vertical imbalance, lateral imbalance, sharpness of image at both the near and far point, stereopsis, visual form span, and the blind spot were shown to bear no significant relation to the span of recognition.

These conclusions of the study are further supported by case-study data which show that the reader with the broad span of recognition is differentiated in some cases from the reader with the narrow span by definitely superior psychological abilities. At the same time there may be no such clear distinction in the visual abilities of the two types of readers. In other cases it appears that a broad span of recognition may be acquired by a student relatively low in other psychological abilities. Thus this study affords some evidence that the reader with the wide span of recognition may show a varied pattern of other psychological and visual abilities, but of these two types of abilities, the former is the more likely to be significantly correlated with the mature span of recognition than the latter.

Other conclusions secondary to the main problem of the study were arrived at in the course of the investigation. Two of these conclusions appear to be of sufficient importance to merit attention at this point. The first of these has to do with the extent of the development of the span of recognition. It was pointed out in chapter iv that the median college student read materials of second-grade level of difficulty with an average span of recognition of seven or eight letters, thus displaying an average span of recognition approximately three times as large as that of the median second-grade student. Such evidence indicates that the median college freshman clearly does not utilize whole phrases in his reading, but on the contrary reads materials eleven grades below his proper level of difficulty with average pauses of the eyes that encompass one or two words of moderate length only.

A second subsidiary conclusion of the study relates to speed of association. This factor, defined for the purpose of this study as the time taken to complete a simple thought by associating an idea aroused by a given visual symbol with another, was investigated for both verbal and non-verbal materials. The results of the measurement of this factor showed that on the average (1) non-verbal stimuli are characteristically associated faster than are verbal stimuli, and (2) differences in speed of association are large during the second and third grades, but tend to decrease rapidly thereafter until differences are practically negligible at the ninth- and thirteenth-grade levels. Since speed of verbal association was significantly associated with the span of recognition at five out of seven grade levels whereas speed of non-verbal association was in no case so associated, it may be concluded that speed of verbal association is a specifically learned perceptual function in which the average student does not as readily respond as he does to non-verbal stimuli until after the period of the middle grades.

It should be reaffirmed that the evidence presented in this study need be considered at all times with full regard to the nature of the tests and techniques which were used. While most of the tests were of a standard type, certain ones such as those for the span of perception, speed of association, and visual form span were devised experimentally for the purpose of this study. The relationship which each of the factors investigated bears to the span of recognition is thus qualified by the

instrument used to measure the factor in question, as well as by the techniques employed in its administration and in the interpretation of the results of such measurement.

Implications of the Study for Training in the
Development of the Span of Recognition
and for Further Research

Training in the development of a broad span of recognition.--At the outset of this study, attention was called to the fact that a primary function of the study was the identification of certain factors or types of factors which show a significant degree of relationship to the span of recognition. As the conclusions of this study indicate, those factors which may be termed psychological or intellectual in character assume greater importance than do the visual factors studied. On the basis of such conclusions, then, it would appear that an important implication for training to develop a broad and mature span of recognition is basic attention to the psychological factors of the reading process, such as those measured in this study, or the components of such factors. Reading itself is fundamentally a complex psychological or intellectual process, its purpose being to derive meaning from the printed page. Derivation of meaning, on the other hand, is merely another way of saying that comprehension is the primary goal of the reading process. Comprehension retains its importance as a primary factor in this process no matter how slowly or how rapidly one reads, no matter how simple or how difficult the material is. However, one mark of the efficient reader is that he has mastered the fundamentals of the reading process to such an extent that he grasps the material in increasingly large thought units, and consequently needs pay less attention to the minute details of word recognition. In other words, he has a comparatively large span of recognition.

In order to achieve such proficiency in reading, it seems almost elementary to insist that a command of the fundamental processes of word recognition, of regular habits of progress of the eyes across the page with clean-cut return sweeps to the next line, and of the ability to understand thoroughly what is read be attained first of all. Once good elementary habits are acquired, it then becomes the function of the school to see that the total habit may be adjusted to different types of materials and to

different rates of reading these materials in accordance with the type of comprehension that is expected. The results of the present study appear to indicate that there are many students in the upper grades who read ridiculously easy material of second-grade level of difficulty with reading habits that are characteristic of that level. The process of adjustment appears to this writer to be essentially one of a psychological nature in which early reading habits must be refashioned and remoulded to fit the stature of mature reading. Such an interpretation is in accord with that advanced for the span of recognition in the preceding chapter: that the span of recognition is a phase of the psychological process of visual perception.

Emphasis upon psychological factors in such training, however, should not be construed to mean that visual factors such as those investigated are of no importance. According to the results of this study, visual factors were not significantly associated with differences in the span of recognition of subjects representing a wide range of reading ability. However, that is not to say that in individual cases visual defects may not be of great importance. They may be significant contributing causes of poor reading performance in many cases if for no other reason than that serious visual defects may cause ocular strain and discomfort which may greatly interfere with the reading process. While visual defects may, on the other hand, be compensated for by increased effort in reading on the part of the student, it seems reasonable to assume that the existence of such defects, whether in good reader or poor, is nevertheless a drain on the nervous energy of the reader and should be remedied. Alleviation of visual discomfort through the correction of visual defects may not, of course, produce startling improvement in school achievement. However, if such treatment serves to make reading and other visual tasks easier, it is important that the ocular correction be made. From this point of view the diagnosis, correction, and prevention of ocular defects may be considered a desirable requisite to training in the development of a mature span of recognition.

Implications for further research.--Further productive research, the evidence implies, should relate to psychological factors, only some of which have been considered in this study. More specifically, the refinement of some of the measures used in

this study seems desirable. This is true, for example, of the materials used to determine the span of perception, for further experimentation in the use and standardization of such materials would be of value both as practice exercises to quicken habits of perception and as measures of relative breadth of span. Furthermore, the preliminary experimentation which was carried out with regard to speed of association appears to the writer to hold promise for future investigation. Still another area of research which is vitally important is the development of more adequate measures of comprehension in reading in order that the full outcomes of the reading process may be more accurately determined. Careful check upon comprehension in connection with training in the development of the span of recognition is essential if superficial reading habits with disregard of content are to be prevented.

A second type of implication of this study for further research has to do with a more intensive investigation of those factors or their component parts which appear to be most significantly related to the span of recognition. It was early stressed in this study that this investigation was more concerned with identifying certain factors or groups of factors and demonstrating their relationship to the span of recognition than it was with analyzing with a high degree of exactness the relative importance of certain basic causal factors, the sum total of which may be said to represent a function such as the span of recognition. The latter type of approach to this problem is properly that of factorial analysis. The use of such a technique, however, should throw additional light upon the complex nature of the span of recognition. The findings of this study indicate, furthermore, that such a type of research will probably be more profitable in the area of the psychological factors involved in reading than in the study of visual functions in this connection.

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A P P E N D I X I

Materials Used for Exposure
in the Tachistoscope

□

+

i

o

me

u s

see

had

fast

what

going

pretty

jump up

good boy

small pig

it is blue

he says yes

find his way

your big doll

two red apples

we want to play

her cat ran away

then go back home

she called one man

give them more food

there are many birds

children like my toys

father and mother came

walk under a green tree

look at three brown eggs

they sleep in the morning

run into that school house

A P P E N D I X I I

Materials Used to Measure Non-verbal
Speed of Association



A P P E N D I X I I I

Tables Showing the Distribution of Scores upon
the Tests of the Psychological and Visual
Factors Included in the Study

TABLE 34
DISTRIBUTION OF THE AVERAGE NUMBER OF REGRESSIONS
PER LINE, ARRANGED ACCORDING TO GRADES

Average Number of Regressions per Line	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
0.0-0.4.....	...	1	...	...	3	...	12	16
0.5-0.9.....	...	3	1	5	3	13	16	41
1.0-1.4.....	1	4	3	8	6	11	6	39
1.5-1.9.....	...	2	5	8	5	7	...	27
2.0-2.4.....	1	1	5	4	6	3	...	20
2.5-2.9.....	1	2	4	3	2	1	1	14
3.0-3.4.....	5	4	3	4	3	...	...	19
3.5-3.9.....	1	1	1	2	...	...	...	5
4.0-4.4.....	2	1	...	...	2	...	...	5
4.5-4.9.....	...	1	1	1	...	...	...	3
5.0-5.4.....	4	1	...	...	...	...	...	5
5.5-5.9.....	...	1	1	...	...	...	...	2
6.0-6.4.....	2	...	...	...	...	...	...	2
6.5-6.9.....	...	...	...	...	...	...	...	0
7.0-7.4.....	1	...	...	...	...	...	...	1
7.5-7.9.....	...	...	...	...	...	...	...	0
8.0-8.4.....	...	...	...	...	...	...	...	0
8.5-up.....	1	...	...	...	...	...	...	1
Total.....	19	22	24	35	30	35	35	200
Median.....	4.1	2.5	2.3	1.7	1.8	1.2	0.7	...
Mean.....	4.5	3.4	2.5	2.0	1.9	1.3	0.7	...
S.D.	1.9	1.8	1.1	1.0	1.1	0.5	0.5	...

TABLE 35

DISTRIBUTION OF THE LENGTH OF THE EYE-MOVEMENT RECORD,
ARRANGED ACCORDING TO GRADES

Length of Eye- Movement Record (cm.)	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
5.0- 9.9.....	...	...	...	...	...	...	1	1
10.0- 14.9.....	...	...	...	...	...	...	7	7
15.0- 19.9.....	...	1	1	...	3	3	16	24
20.0- 24.9.....	...	...	1	4	3	13	7	28
25.0- 29.9.....	...	4	7	12	8	10	3	44
30.0- 34.9.....	...	3	2	4	5	6	...	20
35.0- 39.9.....	1	1	3	5	5	3	1	19
40.0- 44.9.....	...	2	4	3	2	...	...	11
45.0- 49.9.....	1	2	3	3	2	...	...	11
50.0- 54.9.....	2	2	...	4	1	...	...	9
55.0- 59.9.....	1	3	1	...	1	...	...	6
60.0- 64.9.....	3	1	1	...	...	...	...	5
65.0- 69.9.....	1	1	...	...	...	...	...	2
70.0- 74.9.....	2	...	...	...	...	...	...	2
75.0- 79.9.....	...	...	1	...	...	...	...	1
80.0- 84.9.....	1	1	...	...	...	...	...	2
85.0- 89.9.....	...	...	...	...	...	...	...	0
90.0- 94.9.....	...	...	...	...	...	...	...	0
95.0- 99.9.....	2	...	...	...	...	...	...	2
100.0-104.9.....	2	...	...	...	...	...	...	2
105.0-109.9.....	...	...	...	...	...	...	...	0
110.0-114.9.....	1	1	...	...	...	...	...	2
115.0-119.9.....	1	...	...	...	...	...	...	1
120.0-124.9.....	...	...	...	...	...	...	...	0
125.0-129.9.....	1	...	...	...	...	...	...	1
Total.....	19	22	24	35	30	35	35	200
Median.....	72.5	45.0	36.7	31.9	30.7	20.8	17.8	...
Mean.....	78.3	47.5	38.5	35.3	32.5	26.3	18.5	...
S.D.	25.5	21.3	13.5	9.6	10.0	5.45	5.6	...

TABLE 36

DISTRIBUTION OF MENTAL AGE SCORES FOR 165 MOOSEHEART
STUDENTS, ARRANGED ACCORDING TO GRADES

Mental Age (in Years and Months)	Grade Level						Total
	II	III	IV	V	VI	IX	
6-7 to 6-12.....	1	...	...	...	...	...	1
7-1 to 7- 6.....	3	...	...	...	...	...	3
7-7 to 7-12.....	3	1	1	...	...	...	5
8-1 to 8- 6.....	7	1	1	...	...	...	9
8-7 to 8-12.....	2	6	2	...	...	...	10
9-1 to 9- 6.....	1	7	3	...	...	...	11
9-7 to 9-12.....	2	1	3	1	1	...	8
10-1 to 10- 6.....	...	4	...	2	3	...	9
10-7 to 10-12.....	...	1	6	6	3	...	16
11-1 to 11- 6.....	...	...	4	9	6	...	19
11-7 to 11-12.....	...	1	1	4	2	...	8
12-1 to 12- 6.....	...	...	2	6	6	1	15
12-7 to 12-12.....	...	...	...	2	...	2	4
13-1 to 13- 6.....	...	...	1	2	5	...	8
13-7 to 13-12.....	...	...	...	...	2	1	3
14-1 to 14- 6.....	...	...	...	2	1	4	7
14-7 to 14-12.....	...	...	...	1	...	2	3
15-1 to 15- 6.....	...	...	...	...	...	8	8
15-7 to 15-12.....	...	...	...	...	...	2	2
16-1 to 16- 6.....	...	...	...	...	...	2	2
16-7 to 16-12.....	...	...	...	...	...	5	5
17-1 to 17- 6.....	...	...	...	...	...	1	1
17-7 to 17-12.....	...	...	...	...	1	2	3
18-1 to 18- 6.....	...	...	...	...	...	3	3
18-7 to 18-12.....	...	...	...	...	...	...	0
19-1 to 19- 7.....	...	...	...	...	...	2	2
Total.....	19	22	24	35	30	35	165
Median.....	8-3	9-4	10-9	11-7	12-1	15-7	...
Mean.....	8-2	9-5	10-5	11-9	12-1	15-10	...
S.D.	9.5	10.6	15.9	13.8	18.9	20.9	...

TABLE 37

DISTRIBUTION OF SCORES UPON THE AMERICAN COUNCIL
PSYCHOLOGICAL EXAMINATION MADE BY 35
THIRTEENTH-GRADE STUDENTS

Derived Score*	N
10-11	1
12-13	2
14-15	3
16-17	2
18-19	3
20-21	8
22-23	8
24-25	2
26-27	6
Total	35
Median.	20.4
Mean.	20.6
S.D.	4.3

*M = 20) for entire thirteenth-grade class.
 S.D. = 4)

TABLE 38

DISTRIBUTION OF READING RATE SCORES UPON THE COURTIS
SILENT READING TEST FOR 122 MOOSEHEART STUDENTS,
ARRANGED ACCORDING TO GRADES

Words per Minute	Grade Level					Total
	II	III	IV	V	VI	
30- 49.....	1	...	...	...	...	1
50- 69.....	7	...	...	...	...	7
70- 89.....	4	2	2	1	...	9
90-109.....	2	2	2	...	...	6
110-129.....	2	3	5	5	3	18
130-149.....	...	2	3	2	6	13
150-169.....	1	4	3	1	5	14
170-189.....	1	1	4	6	2	14
190-209.....	...	4	3	12	4	23
210-229.....	...	2	1	2	...	5
230-249.....	...	...	...	1	...	1
250-269.....	...	1	1	...	...	2
270-289.....	...	...	...	2	2	4
290-309.....	...	...	...	3	1	4
310-330.....	...	1	...	...	...	1
Total.....	18 ^a	22	24	35	23 ^b	122
Median.....	72.5	155.0	140.0	192.1	154.0	...
Mean.....	86.7	115.6	152.6	192.6	175.3	...
S.D.	36.4	58.2	44.6	53.6	50.0	...

^aOne student failed to mark test as instructed.

^bSeven tests were found to be defective when scores were checked.

TABLE 39

DISTRIBUTION OF READING RATE SCORES UPON THE TRAXLER
SILENT READING TEST FOR 35 NINTH-GRADE STUDENTS

Words per Minute	N
200-249	2
250-299	3
300-349	7
350-399	8
400-449	5
450-499	5
500-549	3
550-599	2
Total	35
Median.	.384.4
Mean.	.393
S.D.	.92

TABLE 40
DISTRIBUTION OF READING RATE SCORES UPON THE PRESSEY
READING RATE AND COMPREHENSION TEST FOR 35
THIRTEENTH-GRADE STUDENTS

Derived Score*	N
10-11	2
12-13	2
14-15	3
16-17	4
18-19	4
20-21	7
22-23	5
24-25	4
26-27	2
28-29	2
Total	35
Median.	20.7
Mean.	19.8
S.D.	4.7

*M = 20)
S.D. = 4) for entire thirteenth-grade class.

TABLE 41

DISTRIBUTION OF READING COMPREHENSION SCORES UPON THE
COURTIS SILENT READING TEST FOR 122 MOOSEHEART
STUDENTS, ARRANGED ACCORDING TO GRADES

Index of Comprehension ^a	Grade Level					Total
	II	III	IV	V	VI	
36- 40.....	2	...	...	...	...	2
41- 45.....	1	...	...	...	...	1
46- 50.....	...	1	1	...	...	2
51- 55.....	1	...	1	...	1	3
56- 60.....	2	...	...	...	...	2
61- 65.....	1	2	1	1	...	5
66- 70.....	2	...	...	...	...	2
71- 75.....	2	3	1	1	...	7
76- 80.....	1	3	2	3	2	11
81- 85.....	1	2	2	4	1	10
86- 90.....	2	4	1	1	3	11
91- 95.....	2	3	3	16	10	34
96-100.....	1	4	12	9	6	32
Total.....	18 ^b	22	24	35	23 ^c	122
Median.....	71.0	86.0	96.0	93.3	93.3	...
Mean.....	70.2	83.0	88.1	90.7	90.7	...
S.D.	13.4	17.9	1.5	4.72	9.75	...

^aIndex of Comprehension is defined in the manual accompanying the test as "The per cent the difference between the right and wrong answers is of the right answers."

^bOne student failed to mark test as instructed.

^cSeven tests were found to be defective when scores were checked.

TABLE 42
DISTRIBUTION OF READING COMPREHENSION SCORES
UPON THE TRAXLER SILENT READING TEST
FOR 35 NINTH-GRADE STUDENTS

Raw Scores	N	Per Cent
20.....	2	100
18.....	5	90
16.....	5	80
14.....	4	70
12.....	8	60
10.....	2	50
8.....	5	40
6.....	3	30
4.....	1	20
Total.....	35	...
Median.....	12	...
Mean.....	12.7	...
S.D.	4.3	...

TABLE 43
DISTRIBUTION OF READING COMPREHENSION SCORES UPON THE
PRESSEY READING SPEED AND COMPREHENSION TEST
FOR 35 THIRTEENTH-GRADE STUDENTS

Derived Score*	N
5- 6	1
7- 8	0
9-10	0
11-12	1
13-14	0
15-16	1
17-18	10
19-20	7
21-22	12
23-24	1
25-26	2
Total	35
Median.	19.9
Mean.	19.3
S.D.	3.58

*M = 20) for entire thirteenth-grade class.
S.D. = 4)

TABLE 44

DISTRIBUTION OF PARAGRAPH COMPREHENSION SCORES UPON THE
NEW STANFORD READING TEST FOR 160 MOOSEHEART
STUDENTS, ARRANGED ACCORDING TO GRADES

Raw Score	Grade Level						Total
	II	III	IV	V	VI	IX	
15- 24.....	1	...	...	...	...	...	1
25- 34.....	5	...	2	...	...	...	7
35- 44.....	9	4	2	1	...	...	16
45- 54.....	2	4	5	1	...	...	12
55- 64.....	1	6	3	3	3	1	17
65- 74.....	...	5	6	5	4	1	21
75- 84.....	...	2	3	10	10	...	25
85- 94.....	...	1	2	9	7	3	22
95-104.....	...	...	1	4	2	7	14
105-114.....	...	...	...	...	2	17	19
115-119.....	...	...	...	...	...	6	6
Total.....	18 ^a	22	24	33 ^b	28 ^b	35	160
Median.....	38.3	61.7	65.0	81.5	82.0	108.3	...
Mean.....	31.8	59.5	62.4	79.2	82.0	94.6	...
S.D.	9.0	13.8	18.37	14.24	13.0	12.9	...

^aOne student absent.

^bTwo students absent.

TABLE 45

DISTRIBUTION OF PARAGRAPH COMPREHENSION SCORES UPON
THE PRESSEY GENERAL READING TEST FOR
35 THIRTEENTH-GRADE STUDENTS

Derived Score*	N
15	3
16	6
17	2
18	3
19	2
20	2
21	1
22	3
23	8
24	0
25	2
26	1
27	2
Total.	35
Median	20
Mean	20.2
S.D.	3.66

*M = 20)
S.D. = 4) for entire thirteenth-grade class.

TABLE 46

DISTRIBUTION OF WORD-MEANING SCORES UPON THE NEW STANFORD
READING TEST FOR 160 MOOSEHEART STUDENTS,
ARRANGED ACCORDING TO GRADES

Raw Score	Grade Level						Total
	II	III	IV	V	VI	IX	
25- 34.....	...	2	...	...	...	...	2
35- 44.....	10	...	1	...	...	...	11
45- 54.....	5	3	3	2	...	...	13
55- 64.....	3	11	9	1	1	...	25
65- 74.....	...	5	8	8	7	...	28
75- 84.....	...	1	3	17	12	1	34
85- 94.....	...	...	...	4	5	7	16
95-104.....	...	...	...	1	2	15	18
105-114.....	...	...	...	...	1	8	9
115-124.....	...	...	...	...	...	4	4
Total.....	18 ^a	22	24	33 ^b	28 ^b	35	160
Median.....	44.0	60.5	63.9	78.2	80.0	101.3	...
Mean.....	45.6	58.6	63.2	76.5	80.6	102.0	...
S.D.	7.6	11.6	9.9	10.3	10.8	9.8	...

^aOne student absent.

^bTwo students absent.

TABLE 47

DISTRIBUTION OF WORD-MEANING SCORES UPON THE
PRESSEY GENERAL READING TEST FOR
35 THIRTEENTH-GRADE STUDENTS

Derived Score*	N
13	3
14	0
15	3
16	1
17	5
18	3
19	0
20	2
21	1
22	4
23	3
24	1
25	2
26	5
27	2
Total	35
Median	21
Mean	20.4
S.D.	4.4

*M = 20)
S.D. = 4) for entire thirteenth-grade class.

TABLE 48
DISTRIBUTION OF SPAN OF PERCEPTION SCORES,
ARRANGED ACCORDING TO GRADES

Number of Letter Spaces	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
0- 1.....	...	1	...	...	...	...	1	2
2- 3.....	2	...	1	...	...	...	...	5
4- 5.....	5	...	1	1	...	...	1	8
6- 7.....	8	6	5	4	3	...	...	26
8- 9.....	3	5	8	7	9	6	...	38
10-11.....	1	2	1	6	5	4	4	23
12-13.....	...	1	2	4	2	4	...	13
14-15.....	...	5	3	9	6	14	18	55
16-17.....	...	2	1	2	2	5	3	15
18-19.....	...	...	2	...	1	...	1	4
20-21.....	...	...	...	...	1	...	1	2
22-23.....	...	...	...	2	...	1	5	8
24-25.....	...	...	...	...	1	...	...	1
26-	...	...	...	...	...	1	1	2
Total.....	19	22	24	35	30	35	35	200
Median.....	6.6	9.6	9.3	10.2	11.2	14.5	15.3	...
Mean.....	6.1	10.1	10.0	11.8	11.9	14.1	15.3	...
S.D.	2.0	4.1	4.2	4.1	4.3	3.8	5.0	...

TABLE 49

DISTRIBUTION OF AVERAGE SPEED OF VERBAL ASSOCIATION
PER LINE FOR FIVE GRADES

Average Speed of Association per Line (.1 sec.)	Grade Level					Total
	II	III	IV	V	VI	
10 -12.4.....	...	...	...	...	1	1
12.5-14.9.....	...	1	...	2	6	9
15 -17.4.....	...	6	2	18	8	34
17.5-19.9.....	...	...	5	5	5	15
20 -22.4.....	1	1	7	5	5	19
22.5-24.9.....	2	3	5	2	3	15
25 -27.4.....	1	4	1	1	2	9
27.5-29.9.....	1	3	...	1	...	5
30 -32.4.....	4	1	1	1	...	7
32.5-34.9.....	...	...	1	...	...	1
35 -37.4.....	2	1	1	...	...	4
37.5-39.9.....	...	2	...	...	...	2
40 -42.4.....	1	...	...	...	...	1
42.5-44.9.....	...	...	...	...	...	0
45 -47.4.....	...	...	...	...	...	0
47.5-49.9.....	2	...	...	...	...	2
50 -52.4.....	...	...	...	...	...	0
52.5-54.9.....	...	...	...	...	...	0
55 -57.4.....	...	...	...	...	...	0
57.5-59.9.....	1	...	...	...	...	1
Total.....	15 ^a	22	23 ^b	35	30	125
Median.....	31.6	25.0	21.4	17.2	17.5	...
Mean.....	34.6	24.6	22.7	18.8	18.3	...
S.D.	10.3	7.4	4.5	3.7	4.2	...

^aFour records defective because of reading difficulties.

^bOne record defective because of reading difficulties.

TABLE 50
DISTRIBUTION OF AVERAGE SPEED OF VERBAL ASSOCIATION
PER LINE FOR GRADES IX AND XIII

Average Speed of Association per Line (.1 sec.)	Grade Level		Total
	IX	XIII	
6.0- 6.9.....	...	1	1
7.0- 7.9.....	...	...	0
8.0- 8.9.....	1	6	7
9.0- 9.9.....	1	9	10
10.0-10.9.....	6	8	14
11.0-11.9.....	6	7	13
12.0-12.9.....	7	2	9
13.0-13.9.....	5	1	6
14.0-14.9.....	4	...	4
15.0-15.9.....	2	...	2
16.0-16.9.....	2	1	3
17.0-17.9.....	1	...	1
Total.....	35	35	70
Median.....	12.5	10.2	...
Mean.....	12.7	10.3	...
S.D.	2.1	1.7	...

TABLE 51
DISTRIBUTION OF AVERAGE SPEED OF NON-VERBAL ASSOCIATION
PER LINE, ARRANGED ACCORDING TO GRADES

Average Speed of Association per Line (.1 sec.)	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
6- 7.....	...	...	...	...	...	1	3	4
8- 9.....	...	...	...	...	1	8	19	28
10-11.....	...	3	1	4	5	16	10	39
12-13.....	...	1	4	14	12	8	2	41
14-15.....	1	7	5	6	7	2	1	29
16-17.....	7	2	6	9	3	...	...	27
18-19.....	3	4	6	2	...	...	...	15
20-21.....	5	3	...	...	1	...	...	9
22-23.....	2	...	...	...	...	...	...	2
24-25.....	...	1	...	...	1	...	...	2
26-27.....	...	1	1	...	...	...	...	2
28-29.....	1	...	...	...	...	...	...	1
Total.....	19	22	23*	35	30	35	35	199
Median.....	19.0	16.0	16.5	13.9	13.5	11.1	9.5	...
Mean.....	19.0	17.1	16.6	14.5	14.1	11.1	9.8	...
S.D.	3.2	4.14	5.3	5.1	3.0	1.8	1.7	...

*One defective record.

TABLE 52

DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING
TO GRADES: BINOCULAR ACUITY (DB SERIES)

Per Cent of Binocular Acuity	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
110.....	...	1	7	2	5	4	2	21
100.....	10	11	12	22	17	21	23	116
90.....	7	7	3	7	7	7	9	47
80.....	2	1	2	3	...	1	1	10
70.....	...	2	...	1	1	...	...	4
60.....	...	...	...	...	...	1	...	1
Total.....	19	22	24	35	30	34*	35	199
Median.....	100	100	100	100	100	100	100	...
Mean.....	94.2	93.6	100.0	96.0	98.3	97.4	97.4	...
S.D.	6.7	11.9	4.3	8.3	8.2	9.2	6.0	...

*One subject with injured eye omitted.

TABLE 53

DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING
TO GRADES: FUSION AT THE NEAR POINT (PF SERIES)

Per Cent of Fusion	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
100.....	14	19	21	22	19	27	26	148
90.....	4	1	...	6	7	4	...	22
80.....	...	1	...	3	2	1	1	8
70.....	...	...	...	2	1	1	3	7
60.....	...	...	1	...	...	...	1	2
50.....	...	...	...	...	...	...	2	2
40.....	1	...	1	...	...	1	1	4
30.....	...	...	...	...	...	...	...	0
20.....	...	...	...	...	...	...	...	0
10.....	...	...	...	...	...	...	...	0
0.....	...	1	1	2	1	...	1	6
Total.....	19	22	24	35	30	34*	35	199
Median.....	100	100	100	100	100	100	100	...
Mean.....	94.7	94.5	91.7	89.1	92.0	95.6	88.3	...
S.D.	13.5	19.0	23.7	23.6	18.7	11.9	23.0	...

*One subject with injured eye omitted.

TABLE 54

DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING TO GRADES: VERTICAL IMBALANCE AT THE NEAR POINT (DB SERIES)

Grade Level	Imbalance		Total
	Yes	No	
II.....	3	16	19
III.....	1	21	22
IV.....	4	20	24
V.....	4	31	35
VI.....	3	27	30
IX.....	6	28	34*
XIII.....	3	32	35
Total.....	24	175	199

*One subject with injured eye omitted.

TABLE 55

DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING TO GRADES: LATERAL IMBALANCE AT THE NEAR POINT (DE SERIES)

Grade Level	Imbalance		Total
	Yes	No	
II.....	3	16	19
III.....	1	21	22
IV.....	5	19	24
V.....	4	31	35
VI.....	3	27	30
IX.....	2	32	34*
XIII.....	8	27	35
Total.....	26	173	199

*One subject with injured eye omitted.

TABLE 56

DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING TO GRADES: SHARPNESS OF IMAGE AT THE NEAR POINT (DB SERIES)

Total Number of Meridians Not Sharply Seen by R and L Eyes ^a	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
0.....	12	9	12	22	19	27	29	130
1.....	...	5	3	6	8	3	3	28
2.....	3	2	2	3	2	2	2	16
3.....	...	3	1	2	...	2	...	8
4.....	...	...	2	1	...	...	...	3
5.....	2	1	2	...	...	...	...	5
6.....	1	...	...	...	...	...	1	2
7.....	...	1	1	...	...	...	...	2
8.....	1	...	1	1	1	...	...	4
9.....	...	1	...	...	...	...	...	1
Total.....	19	22	24	35	30	34 ^b	35	199
Median.....	0	1	0.2	0	0	0	0	...
Mean.....	1.6	1.8	1.8	0.9	0.7	0.4	0.4	...
S.D.	2.5	2.4	2.4	1.6	1.7	0.8	1.1	...

^aEach eye tested separately in six meridians.

^bOne subject with injured eye omitted.

TABLE 57

DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING TO GRADES: SHARPNESS OF IMAGE AT THE FAR POINT (DB SERIES)

Total Number of Meridians Not Sharply Seen by R and L Eyes ^a	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
0.....	6	9	9	17	14	19	16	90
1.....	4	3	2	6	7	6	3	31
2.....	2	1	1	4	6	2	3	19
3.....	1	2	...	2	1	2	2	10
4.....	...	1	6	2	...	1	5	15
5.....	1	1	1	2	1	2	1	9
6.....	2	2	1	1	...	1	3	10
7.....	1	1	2	...	...	1	1	6
8.....	1	...	1	1	...	...	1	4
9.....	1	...	...	...	1	...	...	2
10.....	...	2	1	...	...	...	...	3
Total.....	19	22	24	35	30	34 ^b	35	199
Median.....	1	1	3.7	1	1	0	1	...
Mean.....	2.7	2.7	3.0	1.5	1.2	1.3	2.1	...
S.D.	3.0	3.2	3.1	2.0	1.9	1.9	2.4	...

^aEach eye tested separately in six meridians.

^bOne subject with injured eye omitted.

TABLE 58
DISTRIBUTION OF TELEBINOCULAR SCORES, ARRANGED ACCORDING
TO GRADES: STEREOPSIS (DC SERIES)

Per Cent of Stereopsis	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
100.....	3	3	7	9	11	13	5	51
90.....	...	...	2	1	...	2	2	7
80.....	...	...	2	2	1	...	2	7
70.....	3	1	...	5	1	1	2	13
60.....	3	6	2	7	7	6	2	33
50.....	9	9	8	8	7	6	9	56
40.....	...	2	...	1	...	...	...	3
30.....	...	...	2	2	3	2	3	12
20.....	...	1	1	...	...	3	5	10
10.....	...	...	...	...	...	1	2	3
0.....	1	...	...	...	...	...	3	4
Total.....	19	22	24	35	30	34 ^b	35	199
Median.....	50	50	60	60	60	60	50	...
Mean.....	60.0	58.2	68.3	69.1	70.3	51.2	50.3	...
S.D.	22.5	19.2	26.2	21.8	24.7	29.6	31.6	...

*One subject with injured eye omitted.

TABLE 59
DISTRIBUTION OF VISUAL FORM SPAN SCORES,
ARRANGED ACCORDING TO GRADES

Total Average Span on Hori- zontal Axis for R and L Eyes (in degrees)	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
10- 19.....	1	2	2	...	...	...	...	5
20- 29.....	1	...	...	...	1	...	...	2
30- 39.....	3	4	1	2	...	1	...	11
40- 49.....	3	3	3	2	2	1	8	22
50- 59.....	6	3	3	8	4	6	7	37
60- 69.....	1	4	7	7	9	3	11	42
70- 79.....	3	4	4	8	9	11	6	45
80- 89.....	1	...	4	5	3	7	3	23
90- 99.....	...	1	...	1	1	4	...	7
100-109.....	...	...	...	1	...	1	...	2
110-119.....	...	1	...	1	1	...	...	3
Total.....	19	22	24	35	30	34 ^b	35	199
Median.....	52.5	56.7	64.3	68.1	68.9	75.5	62.3	...
Mean.....	51.3	56.8	60.3	68.3	68.2	73.8	61.4	...
S.D.	17.8	25.6	19.4	17.4	16.8	15.7	12.4	...

*One subject with injured eye omitted.

TABLE 60

DISTRIBUTION OF BLIND SPOT SCORES, ARRANGED ACCORDING TO GRADES

Enlargement of the Blind Spot in Either Eye, in Either Hor- izontal or Ver- tical Meridian (in degrees)	Grade Level							Total
	II	III	IV	V	VI	IX	XIII	
0.0- 0.9 ^a	5	3	5	12	15	27	28	95
1.0- 1.4.....	2	2	3	10	3	3	4	27
1.5- 1.9.....	1	4	2	6	3	2	2	20
2.0- 2.4.....	2	2	1	3	4	2	1	15
2.5- 2.9.....	...	2	3	2	1	...	...	8
3.0- 3.4.....	1	2	2	2	2	...	...	9
3.5- 3.9.....	...	3	2	...	...	...	...	5
4.0- 4.4.....	1	1	1	...	...	...	...	3
4.5- 4.9.....	1	...	2	...	...	...	...	3
5.0- 5.4.....	...	...	1	...	...	1	...	2
5.5- 5.9.....	1	...	...	...	...	...	...	1
6.0- 6.4.....	...	1	1	...	...	...	...	2
6.5- 6.9.....	3	...	...	...	...	...	...	3
7.0- 7.4.....	...	...	...	...	...	...	...	0
7.5- 7.9.....	...	...	1	...	...	...	...	1
8.0- 8.4.....	...	...	...	...	...	...	...	0
8.5- 8.9.....	...	...	...	...	...	...	...	0
9.0- 9.4.....	...	...	...	...	...	...	...	0
9.5- 9.9.....	...	...	...	...	...	...	...	0
10.0-10.4.....	1	...	...	...	...	...	...	1
10.5-10.9.....	...	...	...	...	...	...	...	0
11.0-11.4.....	...	1	...	...	1	...	...	2
11.5-11.9.....	1	...	...	...	...	...	...	1
13.0-13.4.....	...	...	...	...	1	...	...	1
21.0-21.4.....	...	1	...	...	...	...	...	1
Total.....	19	22	24	35	30	35	35	200
Median.....	2.4	2.5	2.6	1.3	0.9 ^b	0.9 ^b	0.9 ^b	...
Mean.....	3.0	2.6	2.5	1.2	1.4	0.5	0.5	...
S.D.	2.0	1.8	1.7	0.7	1.2	0.5	0.4	...

^aEnlargement of the blind spot of less than one degree.

^bThe median score is less than one degree in these cases.

